BULLETIN

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NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

1901-1902

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AND

FOURTEENTH ANNUAL REPORT

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

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Bulletin 88 **January, 1902**

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

INSPECTION OF FERTILIZERS

IN 1901

In Coöperation with the State Board
of Agriculture

Analyses of Wood Ashes and Miscellaneous Fertilizing Materials

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

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TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS, 1901

	Cents per pound.
Nitrogen in ammonia salts	16.5
" nitrates	14.0
" dry and fine ground fish, meat, and blood and in high grade mixed fertilizers	16.0
Nitrogen in fine ground bone and tankage	16.0
" medium ground bone and tankage	12.0
Phosphoric acid soluble in water	5.0
" " " ammonium citrate (reverted)	4.5
" " in fine ground bone and tankage	4.
" " in medium ground bone and tankage	4.
" " in coarse bone and tankage	3.
" " in fine ground fish, castor-pomace, and wood-ashes	4.
" " insoluble in mixed fertilizers	2.
Potash as sulphate free from chlorides and in wood ashes	5.
" " muriate	4.25

The above values are based on the wholesale market price for the materials, when sold in large lots at the principal trade centers in New England. The valuation of a ton of any mixed fertilizer based on the above figures will usually fall ten dollars below the retail price at the local agency. This variation includes such fixed charges as cost of mixing, bags, cartage, and freight, salaries and commissions of agents, and interest.

Nitrogen and available phosphoric acid cost more in 1901 than in previous years; but potash remained unchanged. The values for the coming year will be practically the same as for the one just past.

The Fertilizer Inspection in 1901

In accordance with the public statutes, samples of the different brands of fertilizers, licensed to be sold in this state, were collected under the supervision of the secretary of the State Board of Agriculture, Hon. N. J. Bachelder. The analyses of the samples were made at the New Hampshire College Agricultural Experiment Station, under the direction of its chemist, Mr. F. W. Morse. Mr. W. L. Barker of the New Hampshire College assisted in collecting the samples, and Messrs. H. A. Clark, W. W. Braman, and A. L. Sullivan performed the analytical work. One hundred and six brands of fertilizers were collected and analyzed. Four of these brands only were deficient in their composition to such an extent as to lower their valuation below that guaranteed. In other cases there were deficiences in one constituent, but small enough to be offset by excesses in other constituents. Potash and available phosphoric acid were the constituents which were oftenest deficient, but almost always only one of these was below the guarantee in any one fertilizer, and this deficiency was made up by an excess of the other; that is, if potash was found to be lower than the guarantee, available phosphoric acid proved to be higher.

COMPOSITION OF COMMERCIAL FERTILIZERS SAMPLED AND ANALYZED IN 1901.

MANUFACTURER AND BRAND.	Nitrogen.		Phosphoric Acid.							Potash.	
						Total.		Available.			
	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed
AMERICAN AGRICULTURAL CHEMICAL CO.											
Bradley's English Lawn Dressing	4.94	4.95	2.57	3.23	0.85	6.65	6.00	5.80	5.00	3.06	2.50
Bradley's Potato Manure	2.70	2.50	4.35	2.16	2.61	9.12	8.00	6.51	6.00	5.31	5.00
Bradley's Corn Phosphate	2.13	2.06	6.72	2.63	2.10	11.45	10.00	9.35	8.00	1.60	1.50
Bradley's X. L. Superphosphate	2.56	2.50	6.97	3.06	2.52	12.55	11.00	10.03	9.00	2.22	2.00
Bradley's Eclipse Superphosphate	1.11	1.03	5.33	4.77	0.80	10.90	10.00	10.10	8.00	2.12	2.00
Bradley's Complete Fertilizer	3.21	3.30	3.90	2.70	2.85	9.45	7.00	6.60	6.00	8.50	10.00
Bradley's Complete Manure for Potatoes	3.42	3.30	5.70	2.39	2.56	10.65	9.00	8.09	8.00	6.03	7.00
Bradley's Seeding Down Manure	2.37	2.50	7.40	3.33	2.77	13.50	11.00	10.73	9.00	2.13	2.00
Bradley's Potato Fertilizer	1.95	2.06	6.55	2.84	2.11	11.50	10.00	9.39	8.00	2.53	3.00
Clark's Cove Bay State Fertilizer	2.19	2.06	5.60	2.75	2.95	11.30	10.00	8.35	8.00	1.65	1.50
Clark's Cove Potato Fertilizer	2.12	2.06	6.25	2.95	3.15	12.35	10.00	9.20	8.00	3.07	3.00
Cleveland Potato Phosphate	2.00	2.06	6.10	2.73	2.77	11.60	10.00	8.83	8.00	3.65	3.00
Cleveland Superphosphate	2.11	2.06	5.67	3.11	2.77	11.55	10.00	8.78	8.00	1.89	1.50
Crocker's New Rival Ammoniated Superphosphate	1.32	1.03	6.40	2.49	1.83	10.72	10.00	8.89	8.00	2.59	2.00
Crocker's Ammoniated Corn Phosphate	2.23	2.06	5.80	2.93	2.54	11.27	10.00	8.73	8.00	1.72	1.50
Crocker's Potato, Hop, and Tobacco Phosphate	2.08	2.06	6.60	2.55	2.05	11.20	10.00	9.15	8.00	2.82	3.00
Crocker's Grass and Oats Fertilizer	......	.....	6.50	6.57	0.66	13.73	13.00	13.07	11.00	1.94	2.00
Crocker's Potato Special	3.24	3.30	4.90	3.51	1.81	10.22	9.00	8.41	8.00	7.07	7.00
Cumberland Concentrated Phosphate	3.40	2.30	4.85	3.45	1.80	10.10	9.00	8.30	8.00	6.86	7.00
Cumberland Potato Fertilizer	2.01	2.06	6.82	2.56	2.48	11.86	10.00	9.38	8.00	3.37	3.00
Cumberland Complete Superphosphate	2.00	2.06	5.25	3.26	2.40	10.91	10.00	8.51	8.00	1.81	1.50
Cumberland Bone and Potash	.....	......	5.95	4.25	1.82	12.02	11.00	10.20	10.00	2.17	2.00
Cumberland Guano	1.13	1.03	5.90	2.58	1.92	10.40	10.00	8.48	8.00	2.41	2.00

COMPOSITION OF COMMERCIAL FERTILIZERS SAMPLED AND ANALYZED IN 1901—*Continued.*

MANUFACTURER AND BRAND.	Nitrogen.		Phosphoric Acid.							Potash.	
						Total.		Available.			
	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
Darling's Potato Manure	2.44	2·47	5.65	2.18	0.67	8.50	7·00	7.83	6·00	4.86	5·00
Darling's Farm Favorite	2.56	2·06	5.21	4.87	0.85	10.93	9·00	10.08	8·00	3.70	3·00
Great Eastern Northern Corn Special	2.46	2·06	6.10	2.94	2.96	12.00	10·00	9.04	8·00	1.70	1·50
Great Eastern Potato Manure	2.08	2·00	6.60	2.71	1.99	11.30	10·00	9.31	8·00	2.80	3·00
Great Eastern Grass and Oats	......	......	7.00	5.14	1.48	13.62	12·00	12.14	10·00	3.09	2·00
Great Eastern General Fertilizer	1.02	0·82	4.90	3.40	2.65	10.95	10·00	8.30	8·00	4.10	4·00
Packer's Union Gardner's Complete Manure	2.28	2·10	3.62	2.95	1.88	8,45	7·00	6.57	6·00	10.14	10·00
Packer's Union Universal Fertilizer	0.99	0·82	6.10	2.63	2.17	10.90	10·00	8.73	8·00	3.84	4·00
Packer's Union Potato Manure	2.04	2·05	5.45	3.27	2.28	11.00	11·00	8.72	9·00	5.71	6·00
Packer's Union Complete Animal Corn Fertilizer	2.52	2·50	7.30	2.60	1.85	11.75	11·00	9.90	9·00	2.44	2·00
Quinnipiac Corn Phosphate	2.09	2·00	6.00	2.32	2.30	10.62	10·00	8.32	8·00	1.85	1·50
Quinnipiac Potato Phosphate	1.93	2·06	5.91	2.70	2.41	11.02	10·00	8.61	8·00	3.12	3·00
Read's Vegetable and Vine Fertilizer	2.09	2·06	7.25	1.85	2.27	11.37	10·00	9.10	8·00	5.41	6·00
Read's Standard Superphosphate	1.19	0·82	5.40	2.75	2.55	10.70	10·00	8,15	8·00	4.74	4·00
Read's Sampson Brand for Potatoes	2.56	2·06	5.72	2.78	2.20	10.70	10·00	8.50	8·00	3.50	3·00
Read's Potato Manure	2.73	2·40	4.50	2.61	1.91	9.02	7·00	7.11	6·00	10.55	10·00
Read's Farmer's Friend Superphosphate	2.07	2·06	6.21	2.16	3.73	12.10	10·00	8.38	8·00	3.40	3·00
Tucker's Original Bay State Superphosphate	2.32	2·06	4.10	4.14	2.78	11.02	10·00	8.24	9·00	2.27	1·50
Tucker's Special Potato Fertilizer	2.13	2·06	5.60	3.25	2.67	11.52	10·00	8.85	8·00	3.30	3·00
Williams & Clark's Americus Potato Manure	2.10	2·06	5.81	2.94	2.35	11.10	10·00	8.75	8·00	3.24	3·00
Williams & Clark's Ammoniated Superphosphate	2.56	2·50	6.30	3.49	2.56	12.35	11·00	9.79	9·00	2.32	2·00
Soluble Pacific Guano	2.04	2·06	5.38	3.19	2.93	11.50	10·00	8.58	8·00	1.45	1·50
Standard Fertilizer	2.11	2·06	6.06	2.59	3.35	12.00	10·00	8.65	8·00	1,82	1·50
Standard Special for Potatoes	2.03	2·06	6.77	2.03	3.48	12.27	10·00	8.80	8·00	3.29	3·00
Ten per cent. Pacific Guano	2.42	2·40	4.30	2.23	1.72	8.25	7·00	6.53	6·00	9.61	10·00
Fine Ground Bone	2.39	2·47	......	......	......	25.80	22·80	....	....	....	
Pacific Potato Special	2.24	2·06	5.92	2.88	3.20	12.00	10·00	8.80	8·00	3.27	3·00

American Farmer's Fertilizer Co.											
American Farmer's Market Garden Special	3.09	3.40	7.35	0.89	1.91	10.15	9.00	8.24	8.00	7.05	7.00
Armour Fertilizer Works.											
Armour's All Soluble	3.89	2.88	3.55	4.70	1.77	10.02	10.00	8.25	8.00	4.00	4.00
Armour's High Grade Potato	1.67	1.64	8.45	1.28	0.72	10.45	10.00	9.73	8.00	8.57	10.00
Armour's Ammoniated Bone with Potash	2.60	2.47	1.90	3.81	1.96	7.70	8.00	5.74	6.00	3.01	2.00
Armour's Grain Grower	1.36	1.64	8.00	1.73	1.10	10.83	10.00	9.73	9.00	2.44	2.00
Armour's Bone Meal	3.09	2.47	......	......	......	24.20	24 00	....	....	....	
Bowker Fertilizer Co.											
Bowker's Bone and Potash	1.49	0.75	3.17	3.86	2.37	9.40	8.00	7.03	6.00	2.42	2.00
Bowker's Hill and Drill Phosphate	2.14	2.25	4.85	5.01	2.59	12.45	11.00	9.86	9.00	2.06	2.00
Bowker's Sure Crop Bone Phosphate	0.86	0.75	2.47	6.26	2.27	11.06	11.00	8.73	9.00	2.16	2.00
Bowker' Potato and Vegetable Phosphate	1.85	1.50	4.80	3.62	1.68	10 10	11.00	8.42	9.00	2 74	2.00
Bowker's Corn Phosphate	1.57	1.12	3.67	4.81	2.52	11.00	10.00	8.48	8.00	2.10	2.00
Twenty-five Dollar Phosphate	1.56	1.64	3.85	3.98	1.92	9.75	....	7.83	7.00	1.22	1.00
Bowker's Bone and Wood Ash Fertilizer	1.62	1.50	trace	5.51	3.24	8.75	8.00	5.51	6.00	2.61	2.00
Bowker's Superphosphate with Potash	......	......	2.80	6.49	2.21	11.92	12.00	9.71	10.00	1.33	1.00
Star Special for Potatoes	1.56	1.64	3.40	4.02	1.50	8.92	....	7.42	7.00	3 06	3.00
Dollar Brand	0.93	0.83	4.50	4.58	2.22	11.30	....	9.08	8.00	1.17	1.00
Stockbridge Corn Manure	2.89	3.00	4.80	3.48	1.17	9.45	9.00	8.28	7.00	7 05	7.00
Stockbridge Potato and Vegetable Manure	2.98	3.00	3.85	2.75	2.25	8.85	8.00	6.60	6.00	9.39	10.00
Stockbridge Vegetable and Potato Manure	3.19	3.25	2.22	4.83	2.82	9.87	8.00	7.05	6.00	7.00	7.00
Stockbridge Manure for Strawberries and Small Fruit	2.39	2.25	6.45	4.66	2 44	13.55	7.00	11.11	6.00	4.38	4.00
E. Frank Coe Co.											
E. Frank Coe's Celebrated Special Potato	1.77	1.65	6.70	2.35	1.95	11.00	9.50	9.05	8.00	3.95	4.00
E. Frank Coe's Columbian Potato Fertilizer	1.57	1.20	6.50	3.13	2.87	12.50	9.50	9 63	8.50	2.85	2.50
E. Frank Coe's Famous Grass and Grain	0.89	0.80	4.97	4.33	2.90	12.20	9.00	9.30	8.00	1.96	1.00
E. Frank Coe's Columbian Corn Fertilizer	1.34	1.23	5.62	3.88	2.30	11.80	10.50	9.50	8.50	3.57	2.50
E. Frank Coe's High Grade Ammoniated Bone	1.85	1.65	7.75	2.58	1.97	12.30	10.50	10.33	9.00	2.31	2.25
E. Frank Coe's Famous Red Brand	3.52	3.40	6.90	1.84	1.36	10.10	10.50	8.74	9.00	9.80	10.00
E. Frank Coe's New England Corn	0.97	0.80	5.38	3.53	3.09	12.05	9.00	8.96	7.50	2.92	3.00
E. Frank Coe's New England Potato	1.06	0.80	5.05	3.95	2.95	11.95	9.00	9.00	7.50	3.00	3.00

COMPOSITION OF COMMERCIAL FERTILIZERS SAMPLED AND ANALYZED IN 1901—*Continued.*

MANUFACTURER AND BRAND.	Nitrogen.		Phosphoric Acid.							Potash.	
						Total.		Available.			
	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
LISTER'S AGRICULTURAL CHEMICAL WORKS.											
Lister's Success Fertilizer	1.94	1·24	6.75	2.35	2.12	11.22	11·00	9.10	9·00	3.03	2·00
Lister's Special Corn and Potato Fertilizer	1.85	1·55	5.52	2.00	2.48	10.00	9·00	7.52	8·00	3.56	3·00
Lister's U. S. Superphosphate	1.54	1·03	5.60	2.76	2.64	11.00	10·00	8.36	8·00	2.88	2·00
Lister's Animal Bone and Potash	......	......	7.05	4.09	1.23	12.37	11·00	11.14	10·00	2.55	2·00
LOWELL FERTILIZER CO.											
Swift's Lowell Potato Manure	1.68	1·64	4.27	3.15	2.25	9.67	8·00	7.42	7·00	4.37	4·00
Animal Brand for all Crops	2.64	2·47	6.87	2.72	2.21	11.80	10·00	9.59	9·00	4.17	4·00
Swift's Lowell Potato Phosphate	2.69	2·47	6.18	2.23	1.99	10.40	9·00	8.41	8·00	5.42	6·00
Swift's Lowell Bone Fertilizer for Corn and Grain	1.68	1·64	6.40	1.10	1.51	10.80	9·00	9.30	8·00	3.83	3·00
Swift's Lowell Fruit and Vine for Strawberries	3.54	3·29	6.02	2.33	1.85	10.20	9·00	8.35	8·00	5.90	6·00
Swift's Lowell Lawn Dressing	4.17	4·11	5.91	1.49	0.75	8.15	8·00	7.40	7·00	5.85	5·00
Swift's Lowell Ground Bone	1.92	2·47	......	......	......	29.00	25·00	....	....	....	....
Swift's Lowell Market Garden Manure	3.76	4·10	5.10	2.28	2.17	9.55	8·00	7.38	7·00	4.68	6·00
NEW ENGLAND FERTILIZER CO.											
New England Potato Fertilizer	1.68	1·64	3.05	3.59	2.16	8.80	8·00	6.64	7·00	4.76	4·00
New England Corn Phosphate	1.77	1·64	4.10	3.65	1.98	9.73	9·00	7.75	8·00	4.28	3·00
Acid Phosphate	......	......	12.05	2.30	3.40	17.75	....	14.35	12·00	....	....
New England High Grade Truck Fertilizer	3.38	3·30	4.40	1.55	1.50	7.50	7·00	5.95	6·00	10.43	10·00

PARMENTER & POLSEY FERTILIZER CO.												
Special Potato Manure	3.75	3.50	3.05	5.01	1.84	9.90	9.00	8.06	8.00	7.64	7.00
Plymouth Rock Brand	2.89	2.47	2.40	5.61	3.91	11.92	9.00	8.01	8.00	4.76	4.00
P. & P. Potato Fertilizer	1.78	1.64	2.00	4.00	4.45	10.45	7.00	6.00	6.00	6.50	6.00
RUSSIA CEMENT CO.											
Essex XXX Fish and Potash	2.54	2.10	3.77	4.76	4.67	13.20	12.00	8.53	9.00	2.31	2.20
Essex Complete Manure for Corn, Grain, and Grass	3.61	3.30	3.92	2.92	3.56	10.40	9.50	6.84	7.00	9.55	9.50
Essex Complete Manure for Potatoes, Roots, and Vegetables	4.65	3.70	5.45	2.77	1.45	9.67	9.00	8.22	7.00	8.21	8.50
Essex A 1 Superphosphate	1.20	1.00	1.47	4.88	5.62	11.97	9.00	6.35	7.00	2.00	2.00
W. E. WAY.											
Granite State Fertilizer, Potato Brand	2.97	3.00	5.05	3.30	0.85	9.20	8.00	8 35	7.00	7.29	7.00
Granite State Fertilizer, Reliable Brand	2.28	2.25	6.03	2.32	1.50	9.85	9.00	8.35	8.00	3.87	4.00
Granite State Fertilizer, Harvest Brand	1.62	1.50	5.80	3.18	1.65	10.64	9.00	8.99	8.00	2.39	2.00
Granite State, Grass and Grain	1.37	0.75	1.85	4.13	3.07	9 05	7.00	5.98	6.00	2.66	2.00
Granite State, Meadow King	......	......	5.77	4.17	1.44	11.38	11.00	9.95	10.00	2.23	2.00

ANALYSES OF ASHES AND OTHER FERTILIZING MATERIALS SENT IN FOR EXAMINATION

WOOD ASHES

SENT FROM:	Composition expressed in pounds per 100.			
	Moisture.	Phosphoric acid.	Soluble potash.	Total potash.
Walpole	18.97	1.42	4.27	6.00
Lancaster..................	19.06	2.49	5.57	6.41
Hinsdale..................	7.89	1.71	4.91	5.44
Rochester.................	22.69	1.44	3.76	4.65
Greenland	6.23	1.22	4.08	5.48
Dover	14.89	1.75	3.93	5.17
Stratham	Undeterm'd	.36	2.90	3.98
Hinsdale..................	9.21	.64	.92	2.42
Walpole....................	19.57	1.96	2.08	3.75
Grange	12.90	.88	.73	5.19

Several of the above samples represented some very inferior lots of ashes. The last two were described as lime-kiln ashes.

The availability of insoluble potash in wood ashes is unknown, consequently we recommend purchasers to exact a guaranteed amount of soluble potash.

MISCELLANEOUS FERTILIZING MATERIALS

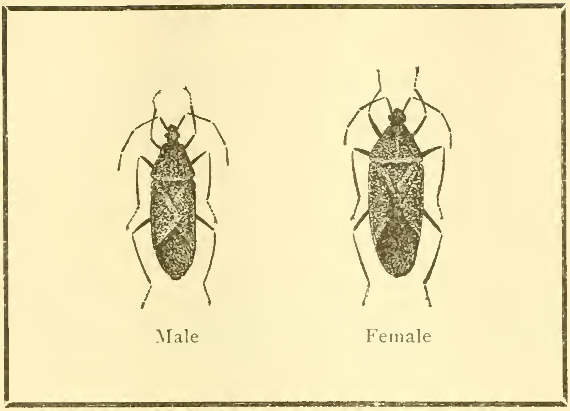
SUBSTANCE:	SENT FROM:	Composition expressed in pounds per 100.		
		Nitrogen.	Phosphoric acid.	Potash.
Fish scrap............	Stratham ..	7.33	15.82	....
Glue "stick".............	" ..	11.99	1 54	....
Ground bone	Exeter.....	1.85	24.99	....
" "	"	3.65	22.52	... .
" "	"	2.79	19.96	....
Meat and bone tankage ..	"	2.44	12.49	....
Nitrate of potash..........	"	13.98	....	44.60

MIXED FERTILIZER

Chicago Fertilizer Co.'s Bone, Blood, and Potash, sent from Rollinsford.

Nitrogen,	1.88	per cent.
Available phosphoric acid,	9.50	"
Total,	11.90	"
Potash,	1.78	"

FRED W. MORSE, *Chemist.*



Male Female

THE SQUASH BUG

BY

CLARENCE M. WEED AND ALBERT F. CONRADI

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

Bulletin 89 **February, 1902**

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

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THE SQUASH BUG

BY CLARENCE M. WEED AND ALBERT F. CONRADI

Perhaps the most notable insect attack of the season of 1901 was that of the Squash Bug[1]—a pest which has long been known as one of the most vexatious insects with which the gardener has to contend. As soon as squashes, cucumbers, and other plants of the vine family were out of the ground in spring the bugs began to destroy them, coming in such extraordinary numbers as to occasion very general comment. And the outbreak seems not only to have been quite generally distributed throughout New Hampshire, but also over a much wider area, complaints having reached us from other states, notably Pennsylvania.

Ever since the publication of the classic treatise on "Insects Injurious to Vegetation," by Dr. T. W. Harris, in which it was discussed, the squash bug has been frequently mentioned in writings about insects. The most complete article is that of Mr. F. H. Chittenden published in Bulletin 19 (new series) of the United States Division of Entomology, but others of some length have been published by various experiment stations. We desire to express our thanks to the Horticultural Department of this Station for coöperation in our experiments with remedial measures.

LIFE-HISTORY

The eggs of the squash bug are generally laid in irregularly shaped clusters, in which the individual eggs are arranged in more or less regular rows. The outlines of these egg masses vary greatly; some are triangular, others are rectangular, others circular, while many others are so irregular that it is not practicable to define their arrangement. In some clusters the eggs are crowded closely together, while in others they may be scattered over the entire surface of the leaf. In the

[1] *Anasa tristis* De G.

arrangement of the individual eggs in adjacent rows there is generally a tendency to alternation. As a rule the eggs are laid on the lower surface of the leaf, but very often, especially when the insects are abundant, they are deposited on the upper surface.

The same bug may lay her eggs in several clusters. This very commonly occurred in the breeding cages when the insects were disturbed while ovipositing. Instances where it occurs in the field are not infrequent. Sometimes but one or two or three eggs will be found upon the leaf. In one of the breeding cages one bug laid twenty-four eggs at one time and later laid forty-three eggs in a batch. She afterwards mated again, but died from the effects of a parasite before she deposited more eggs.

When first laid the eggs are covered with a very fine film of an adhesive substance of a whitish color. In the course of an hour the color changes to a pale yellow-brown, and by the end of a day changes to a fairly dark yellow-brown with a glossy surface. In about eight days the color becomes a bronze brown ; and in twelve days it becomes a coppery bronze, which is yet darker a day or two before hatching. One familiar with these color changes can tell approximately how long the eggs have been laid.

The egg is a small rounded object more or less triangular in its general outline. It is of nearly equal length and thickness, about 1-16 inch long by 1-20 wide. In some cases one end is more pointed than the other, while in others the ends are rounded alike. The side of the egg attached to the leaf is flatter than the other sides ; sometimes it is even bent inward. In eggs that have been separated from the leaf one can see an interruption of the generally glossy surface : this is the place where the egg was attached.

The eggs of the squash bug hatch in from six to fifteen days after being laid. In the field they rarely hatch in less than seven days while in the relatively cooler rooms of a building they rarely hatch in less than eight days. In the field our observations indicate an average of eleven days while in the laboratory it was twelve days.

When the tiny bug hatches, a small disc-like portion of the egg shell, near one end and a little above the middle, is pushed out, and the insect emerges through the opening thus made. That there is some provision in the structure of the shell for the breaking off of this disc is evident from the perfect appearance of all the discs. In some cases that were observed in hatching, both in the field and in the laboratory, the fore legs were free; while in about as many others these legs, like the rest of the appendages, were snugly folded to the body, becoming free only when the insect was entirely out of the shell.

The newly-hatched squash bug is more brilliantly colored than at any other time during its life, and these colors make it very conspicuous against the green background of the leaves. The color of the abdomen and the posterior portion of the thorax is light green; that of the legs and "feelers" or antennæ, a beautiful crimson; that of the head and anterior portion of the thorax a lighter crimson, while the margins of the eyes are darker. This beauty, however, is but short-lived; at the end of an hour the crimson is noticeably darker, and in a few hours it changes to a jet black.

The young squash bugs soon begin their attack upon the plant by inserting their tiny beaks in the succulent tissues of the leaves. In their general habits they resemble the adults After about three days of this feeding, the abdomen becomes noticeably swollen and the color somewhat lighter. This is an indication that the period of moulting has arrived.

The young nymphs now assume a quiet, stationary attitude. The process of moulting begins by the splitting of the skin longitudinally along the middle of the upper surface of the body, the split extending along the thorax and the front end of the abdomen. The time required to complete this operation varies greatly: in the field the shortest period we have observed was thirty-two minutes, while in the laboratory six hours have sometimes been required.

A few hours after the first moult when the bugs have taken on their normal colors they are considerably lighter than they were before. The length is now about 1-9 inch. They are also more alert, moving about more rapidly. They feed again upon the sap of the leaves for about nine days when they undergo their second moult. After this has taken place, so that the nymph is in the third of its larval stages, the body is larger and flatter, with the margins more sharply defined and the color somewhat darker than in the second stage. The length is now about 1-8 inch.

The most notable difference taken on by the insect in the fourth stage, which is entered upon by the third moult, which takes place about eight days after the second moult, is the noticeable development of the wing pads. These now become much more conspicuous than before. After living in this stage for about seven days, the insect moults for the fourth time, entering upon its fifth stage. It is now quite different in appearance and is easily recognized as a full grown nymph (Fig. 2). The wing pads are greatly enlarged, while the thorax is widened and lengthened. The body is more rectangular and in general becomes so similar to the mature bug that at a little distance it may readily be mistaken for the latter. It is now 1-3 inch long.

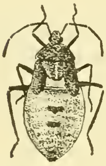

FIG. 2. Squash Bug; stage before adult. Natural size.

The full-grown nymph lives in this fifth stage about nine days before the final moult by which it matures into the adult squash bug, which is so familiar to every gardener that it need not be described here. In the pictures on our title-page the male is represented at the left and the female at the right.

THE SQUASH BUG SINGLE-BROODED

The squash bugs that pass the winter as adults remain in the field in nearly undiminished numbers until nearly the end of July. The eggs upon the leaves are more abundant during this month than at any other time. Early in August, however, the disappearance of the adults becomes noticeable, freshly laid eggs becoming more and more scarce. During August the adults of the new generation become abundant, but none of these lays eggs, nor even do they go through the process of mating before the following spring. Consequently there is but one brood of squash bugs each year.

HIBERNATION

When the autumn frosts blacken the leaves of the vines a considerable proportion of the bugs are still immature. These congregate in great numbers upon the unripe fruit where they suck the juices through the thick skin ; many are thus able to become adult during the mild autumn days. The full-grown insects begin leaving the fields soon after the first frosts, and from that time onward rapidly disappear. Apparently they fly away most commonly during the warmest hours of the day.

For their long winter retreat they seek such shelter as they are able to find in their erratic wanderings. They conceal themselves beneath the fallen leaves, as well as stones and logs and boards in the fields and woods. Board piles seem to be a favorite resort, but almost any sort of shelter may be chosen. Here they remain dormant until again enlivened by the warm sunshine of spring. Then they come forth to wander more or less until the squash plants appear above ground, attracting the bugs to find food and a place to deposit their eggs. On warm days they fly into the squash field with a buzzing noise which is easily recognized. It seems evident that they find their food plants by the sense of smell.

THE INJURIES TO THE PLANT

The squash bug was not the only pest infesting our squash plants the past summer. There were present also the squash root-borer and a fungous disease. These pests do not make their first appearance at the same time. The bug is present when the young plants appear above the ground. A number of bugs attacking such a plant cause it to wither and die. Later when the plants have reached a fair size the root-borer and the fungus appear. The presence of each of these may be determined by the following descriptions of the appearance and behavior of the plants.

Squash Bug.—The effect on larger plants is not general but local. A number of bugs congregated on a leaf will cause that portion to dry up, and this dead portion may vary from a pruinose gray to a dark brownish black.

The Root Borer.—A sudden wilting and drooping of the plant characterizes the attack of this pest, which we believe to be the larva of the striped beetle. (*Diabrotica.*) The plant may appear thrifty in the morning and be prostrated to the ground in the evening. This has been the chief cause of death to the plants that died in the college gardens.

Fungous Disease.—When attacked by this disease the leaves begin to dry up at the margins. The plant turns dark green, similar to the first appearance of the vine when treated with too strong a mixture of kerosene and water. Dried up blotches appear on the leaves and the plant dies without wilting. When a cross section of the vine is examined it exhibits a stratification of colors such as is not characteristic of a healthy plant.

NATURAL ENEMIES

Tachinid Parasite.—The most important natural enemy of the squash bug in New Hampshire last season was a little two-winged fly about the size of the common house fly. This is a parasite belonging to the family of Tachinid (*Ta-ki-nid*) flies and is called by scientists *Trichopoda pennipes.*

The male of this squash bug Tachinid is somewhat smaller than the female, but otherwise they are much alike in appearance. The wings extend about one third their length beyond the tip of the abdomen and are a velvety black, with the exception of the inner margin which is colorless and transparent. The abdomen is a conspicuous yellow while the tip, including a little more than the last two segments, is a jet black. The rear half of the thorax shows two faint longitudinal yellow markings, which may be absent. The front half of the thorax is very beautifully colored with alternate markings of black and a brilliant golden yellow. The front of the head is white; the eyes are black, while between the eyes start two beautiful golden yellow markings diverging downwards and one passing along each side of the white front.

The female fly deposits her small white eggs on the outside of the body of the squash bug. These eggs are about the size of a pin head, rather oval than round, and are flattened on the side attached to the body of the bug. They look like little white pustules. In a short time the egg hatches into a tiny maggot that burrows through the flattened side of the egg shell and through the skin of the squash bug to which this flattened side is fastened, thus finding itself within the body of the bug. There is no visible opening on the shell as one sees it, so that it is difficult to tell when the egg hatches.

On the inside, the little parasitic maggot develops at the expense of the tissues of its host. Here it will remain two weeks or more, toward the end of which time the unfortunate bug will become sluggish and probably die. Then the maggot burrows its way out of the body of the host, commonly appearing through a hole which it makes near the posterior end but in some cases near the thorax. It appears that the maggot seeks to penetrate the body wall of the host at a point where the resistance is least. After thus emerging the parasite finds shelter in the soil of the field. Here its outer skin hardens into a brown case, inside of which the maggot changes to a pupa—the quiet stage in which insects undergo the change of form from a larva to an adult. In two or three weeks the pupa again changes into a fly that breaks through the brown case. Thus the life cycle is completed, and the insect is ready to start another round of existence. At least two broods of this fly occur in one season, as our observations show, and perhaps there are more.

While as a rule but one egg is laid upon one bug at one time, it is not uncommon to find many eggs attached to a single bug. In one case we counted thirty-five so attached. They occur upon any part of the body.

The final effect of the parasite is to weaken and kill the host, but apparently the latter, when a female, often lays part or all of her eggs before being thus killed. So the actual good done by the parasite is not as great as might easily be surmised. As a matter of fact the precise determination of the benefit man derives from insect parasites is a very difficult matter, and especially so in a case like this. Yet there is no doubt that the number of squash bugs was somewhat reduced by these parasites.

The Toad.—The common toad has been generally considered an enemy of the squash bug, being frequently referred to in this connection in articles concerning the pest. We made a large number of observations on this phase of the subject, the most interesting result being the discovery that the odor given off by the bugs will actually kill toads if confined in a small open vessel, such as a wide-mouthed bottle. Some of these experiments as recorded in a published letter by Mr.

Conradi are as follows: [1] When a squash bug nymph of the fifth stage was suddenly introduced into a half pint, open, wide-mouthed bottle containing a half-grown, live toad, so that the batrachian would get the full effects of the pungent fumes secreted by the bug, the toad was thrown into a temporary stupor, the effect being similar to that of chloroform. As the number of bugs was increased the effect on the toad was increased. When as many as seven bugs were introduced the toad fell into a profound stupor from the effects of which it died in the course of twenty-four hours.

On September 8, an adult toad that had been kept in the laboratory vivarium with a scant food supply for several days, was placed in a quart jar of the same construction as the one mentioned above, and eight bugs were introduced; these bugs, however, had been so much disturbed previously that the source of the pungent secretion had been temporarily exhausted. The toad hesitatingly devoured three, after which she would remove with her front feet every specimen that made an attempt to ascend the wall of her enclosure; but these bugs were not eaten. The toad was then transferred to another jar of the same size and construction, and eight bugs were suddenly introduced from the squash leaf so that the animal would get the first and fullest effects of the odor: the result was that the toad went through a series of contortions followed by a short period of stupor similar to that mentioned before. Upon recovery the toad was again removed to the vivarium where it now lives in partial hibernation.

A young, red-spotted salamander was affected and killed as easily as the half-grown toad, while for the common field frog a greater number of bugs were required to bring about similar effects, the frogs also being killed. Many experiments with snakes were tried, but no ill effects from the secretion of the bugs were apparent.

The odor that the bug secretes is contained in a clear, slightly greenish liquid expelled from the extremity of the alimentary canal; when it comes in contact with the air the odor is given off almost instantaneously while the liquid remains to evaporate.

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[1] *Science*, Vol. XIV, *p.* 816, Nov. 22, 1901.

Further observations showed that toads in confinement would eat squash bugs when very hungry, but we do not think that toads ordinarily devour many of the pests.

Egg Parasites.—Two parasites on the egg of the squash bug have been recorded in Mr. Chittenden's article. In Florida these parasites have been known to destroy thirty per cent. of the eggs of the pest, although it is stated that they "appear in the field too late to be of any great service" in preventing damage that season. But they must help to lessen the number of bugs that will be present the next season. None of these parasites was found by us in New Hampshire during the season. The introduction of some from more southern latitudes is one of the measures we are considering for future action.

A Fungous Disease.—In case of a small percentage of bugs that died, careful investigation proved that it was not due to the effects of the tachinid parasite. The body was somewhat shriveled after death. A careful examination of the tissues from various parts of the body revealed the presence of the mycelium of some fungus. This mycelium, however, was never found in a condition for identification.

Mr. Chittenden reports that a similar fungus found by him was thought to be "a conidial stage of some cordyceps." He also mentions a bacterial disease to which the bug is subject; we have seen no signs of this, however, in our New Hampshire studies.

REMEDIAL AND PREVENTIVE MEASURES

It seems to us probable that in the near future the squash bug will make the growing of squashes on a small scale so difficult that the crop will be chiefly grown by specialists who will devote such care and attention to their fields that they are able to bring their plants through all vicissitudes. This has happened in the case of many other crops. It is no longer practicable, chiefly on account of insect and fungous enemies, to grow a few peaches in the garden, yet the commercial growers make a success of this crop. The case is similar with most fruits and many vegetables.

There are two chief reasons why the specialist with a large area planted is able to succeed where his neighbor with a fragmentary area fails. In the first place, where there are several hundred hills of squashes for the bugs of a given locality to attack, the injury will be so much scattered that it will be, relatively, much less severe than where it is concentrated on a half a dozen hills. Consequently, the probability is much greater that a large proportion of the vines will develop without serious injury. In the second place, the owner of the larger plantation' can afford to give it more constant care and attention than the one with a smaller crop is likely to give.

Consequently in the following discussion of preventive and remedial measures it is to be borne in mind that they may not all be practicable for a few hills in the garden, when the bugs were as thick as they were in 1901. It was then no uncommon thing to pick off several dozen bugs from the vines of one hill at a single picking. Under such conditions, only by constant vigilance can one hope to bring a few vines through. But it is believed that the measures outlined will enable one to grow the crops affected when planted in considerable areas.

Protection by nettings.—The most dangerous attack from the squash bug is that made upon the young plants when they first come up, and before they have any but the two seed-leaves. At this period one bug may be able to destroy the plant in a very short time. To prevent this it is often worth while, in garden practice, to cover the hills with netting of some sort. The edges, however, must be very thoroughly buried under the soil, or the bugs will dig under and get inside, where they will be unmolested and soon ruin the plant. Of course this netting has the additional advantage of keeping out the little flea beetles and the yellow and black striped beetles. As soon as the plants get four or five leaves it is better to remove the covering and fight the bugs by other methods.

Excessive seeding.—Most gardeners plant a great many more seeds of squashes, melons, and cucumbers than can develop properly, in order to provide against the destruction of the whole hill by the numerous enemies present. This is especially desirable when the squash bugs are abundant, for with any methods of fighting the pest yet discovered the killing of part of the young plants is almost inevitable.

Good culture.—The squash plant requires a deep, loose seed bed and a fertile soil. If these conditions are favorable, the plant shows great vitality and thrift; in this case the attacks of insect enemies are not so effective. On the other hand, plants grown in a sterile, compact soil are very easily subdued. Therefore, keep the seed bed in good condition by cultivating and weeding it, and thus reduce the obstacles to the development of the plant to a minimum.

Clean culture.—It is generally acknowledged that a system of clean culture on the farm discourages insect pests. The burning of useless rubbish in fields and along fences late in autumn reduces the winter shelter for insects, as well as destroys such as are already present. The collection and destruction of the squash vines after the crop is harvested will tend to discourage the presence of the bugs by preventing the maturing of some of the nymphs, and not attracting winged adults from other fields.

HAND PICKING

The process of collecting the bugs by hand must, apparently, be the main reliance of the gardener against this pest for many years to come. The bugs may be collected from the vines or from the ground beneath them, from boards used as traps, or from squashes planted between the rows of the regular crop as trap plants for the bugs. Collecting from each of these may be briefly discussed under separate headings:

In Spring

1. *From the vines or the ground.*—The full-grown squash bug is the only form present in spring, when hand picking is most essential. It is large and conspicuous, and is readily caught on the leaves of the young plants. Some of the bugs, however, seek shelter in the earth around the base of the stem where they are likely to make a destructive attack upon the plant, and should be looked for. Others are likely to find shelter under leaves lying on the ground, or under clods and stones; such places should be examined carefully. The bugs may be readily driven from such hiding places by a three per cent. spray of kerosene and water, such as is thrown by one

of the kerowater sprayers, a subject discussed more fully in a later paragraph. The eggs should also be destroyed.

During the weeks of late spring, when the bugs are constantly flying in from the surrounding region, the vines will need to be gone over at least twice a day in regions badly infested. The pests come most abundantly during the warmer hours. They are then most active and more difficult to catch than during the cooler hours of morning and evening, but much damage will be prevented by going over the vines about noon. The other picking may be done in the evening or early morning. When collected, the bugs may be killed by crushing, or perhaps thrown into a pail containing kerosene and water. The latter will probably be easier in the case of good-sized areas.

2. *From board traps.*—It has long been known that if small boards, such as old shingles, are laid loosely upon the ground beside the squash vines a large proportion of the bugs will congregate under these at night, so that they are easily collected the next morning. This is well worth practising in connection with the hand picking of the vines.

3. *From trap squash plants.*—The squash bugs, as already indicated, have a decided preference for squashes rather than cucumbers, melons, or other similar vines. In growing the other crops this fact may well be taken advantage of, by planting squashes between the other hills, and a week or so earlier. The attack of the bugs will thus be concentrated upon the squashes, and the hand picking will be more effective. Even in fields of squashes the method may be employed to advantage by planting extra squash seeds between the regular hills, and, if practicable, planting them earlier than the main crop. Of course these trap plants, with whatever eggs there may be upon them, are to be pulled up and so treated as to destroy the eggs before the latter begin to hatch.

In Summer

From the vines and ground.—As the season advances the combating of the pest becomes a more difficult problem. The full grown bugs have laid eggs early in the season ; these hatch and the young nymphs are less conspicuous than the adult. At this time bugs of all sizes are present in greater or less numbers. When the method of handpicking is employed many of these nymphs concealed below clods, old leaves, or other places, or even when exposed upon the surface, are likely to be overlooked. To avoid this it is desirable at this time to use the kerowater spray that will kill the bugs without injuring the vines. An 8 per cent. mixture of kerowater that will kill the bugs is fatal to the tender squash plants. The odor of kerowater, however, is very offensive to the bugs. A mixture having a typical kerosene odor—say 2 per cent.—when sprayed on the plant and ground will cause those bugs which are concealed to come forth and try to escape from the odor. Some of those on the plant will come to the upper surface of the leaves while the others will run over the ground. These can be easily picked, and to make sure of the destruction of the small nymphs spray the ground with an 8 per cent. kerowater mixture. The ground need not be saturated so as to affect the plant, but a light spray of that strength will do the work effectively. When a kerowater spray pump is at hand all that is necessary is to shift the gauge and no new mixture need be prepared.

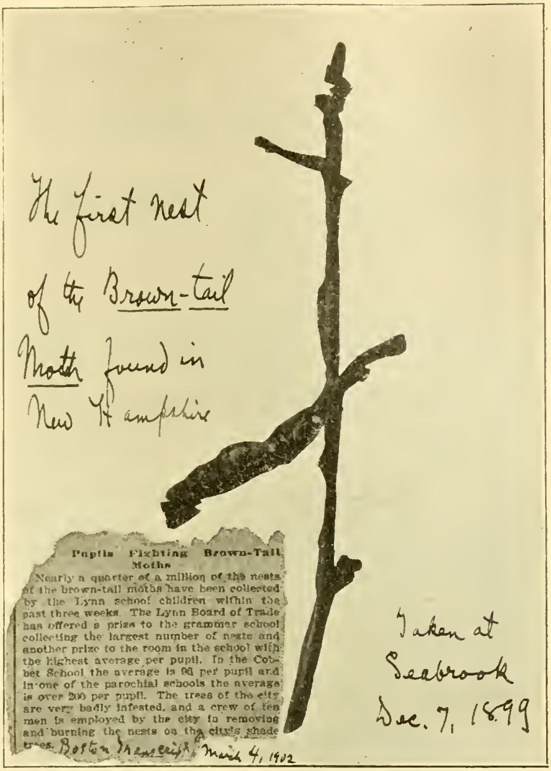
The best time to apply this spray is late in the afternoon when the sun is low; it will be less serious to the plant than it would be during the hotter portion of the day. The kerowater will not evaporate so readily, and the effects will therefore be better. As the stragglers come during the hottest portion of the day such a spray will include these.

When a spray pump is used that throws a stream of kerosene and water in the form of a spray it should never be forgotten that when the action of the pump is discontinued the mixture that is in the tube may separate into the water and the kerosene, the latter rising to the top of the tube. The first stream, therefore, after such rest would contain kerosene in a more or less concentrated form which would tend to kill the plant tissues. When the conditions are such that the pump must be stopped very often, the damage may be considerable. In every case where the pump is started the first stream should be directed upon the ground, or at least away from the plant.

KILLING THE BUGS IN AUTUMN

The squash bug, so far as is known. develops exclusively upon plants of the squash vine family, including besides the squash, pumpkins, melons, cucumbers, and gourds. In New Hampshire none of these plants grow wild to any extent. Consequently the bugs present any spring will be only those that have developed the previous season upon plants grown by man. It is the common practice to pay no attention late in summer and early in autumn to the swarms of young bugs developing upon the vines, because there is little danger of serious injury from them so late in the season. And this is the reason why the following spring the squash bugs swarm into the fields in such enormous numbers. Developing in autumn without molestation, they migrate to the woods or other quarters for winter shelter, remaining there until spring, when they come forth to attack the new crop. And doubtless to a considerable extent every grower may thus be responsible for the attack upon his own vines, though of course there is more or less interchange of bugs from neighboring plantations.

As a result of this condition, it will be readily seen that it is important to kill off as many of the bugs in autumn as possible. This is especially true of the man who grows squashes in a region where few are grown by other people. At least as soon as the first frost kills the vines the plantation should be thoroughly gone over with one of the spray pumps that throws a combination of kerosene and water, and all the bugs which can be reached drenched with at least a ten per cent. mixture of the kerosene. A large proportion of the bugs at this time are in later nymph stages and will be able to develop upon the juices of the stems and the immature squashes. They congregate in great numbers upon the latter, and are there easily drenched with the spray. One should not be content by going over the field a single time. Many of the bugs will surely escape, so that the operation should be repeated as often as any considerable number of bugs are present. We have found the Knapsack Kerowater Sprayer excellent for this work.



The first nest of the Brown-tail Moth found in New Hampshire

Pupils Fighting Brown-Tail Moths

Nearly a quarter of a million of the nests of the brown-tail moths have been collected by the Lynn school children within the past three weeks. The Lynn Board of Trade has offered a prize to the grammar school collecting the largest number of nests and another prize to the room in the school with the highest average per pupil. In the Cobbet School the average is 98 per pupil and in one of the parochial schools the average is over 200 per pupil. The trees of the city are very badly infested, and a crew of ten men is employed by the city in removing and burning the nests on the city's shade trees. Boston Transcript, March 4, 1902

Taken at Seabrook Dec. 7, 1899

INSECT RECORD FOR 1901

BY CLARENCE M. WEED

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION
DURHAM

Bulletin 90 March, 1902

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

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THE INSECT RECORD FOR 1901

BY CLARENCE M. WEED

The season of 1901 was on the whole an average one for insect pests in New Hampshire. There was an unusual outbreak of the squash bug, and an extraordinary appearance of a harmless fly called the white-winged bibio, together with much local damage by cankerworms and railroad worms. In other respects the insect injuries were of the usual sort, though the discovery of the elm leaf-beetle within our borders may well lead us to expect that in the near future we shall have new and more serious pests to fight. A special discussion of this phase of the subject is given on the later pages of this bulletin.

As was to have been expected from the conditions in 1900, no injury was seen or heard of from the work of the FOREST TENT CATERPILLAR[1] or the SPINY ELM CATERPILLAR.[2] The AMERICAN TENT CATERPILLAR[3] was somewhat more abundant than during the years immediately preceding, and is evidently gradually increasing in numbers. The CHOKE CHERRY TENT-MAKER,[4] on the other hand, was noticeably less abundant, the parasites mentioned in my last Insect Record as being so numerous, having apparently reduced its numbers materially.

During the latter part of May and the early part of June a fly called the WHITE-WINGED BIBIO[5] appeared in some parts of the state in enormous numbers. Mr. N. Wentworth of the state Fish and Game Commission sent specimens from Hudson,

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[1] *Clisiocampa disstria* Harris.

[2] *Vanessa antiopa* Linne.

[3] *Clisiocampa americana* Harris.

[4] *Cacoecia cerasivorana* Fitch.

[5] *Bibio albipennis* Say.

June 4, with the statement that millions of them were to be seen on the surface of Sunapee Lake, "all fish taken being full of them." Mr. Laurence J. Webster sent specimens from Holderness, May 27, with the report that they were "infesting many shade and ornamental trees. In some cases they eat the young leaves as they are coming out of the buds; in others they eat the fleshy stems, such as those of horse chestnut trees. On one white thorn shrub they have apparently laid eggs on the inside of the rolled up leaves and have about ruined the appearance of it for the season." Mrs. G. J. Judkins also sent some of the flies from Bristol with the report that they "almost made currant bushes black by their numbers during the first week in June. They did apparently no damage to the currants but treated the pansies shamefully." In a later letter, the same writer sent peony buds believed to have been injured by this same fly, and said: "They simply ruined early flowers. If they have come to stay we will have to fight for pansies, peonies, and the like."

This bibio fly has been known as an abundant insect for a long time. It has frequently been accused of injuries to flowers and foliage, but careful studies have always shown that the work of some other insect was attributed to it. It is natural that its extraordinary abundance and its habit of resting upon flowers and foliage should lead to the inference that any damage that may occur had been caused by it. But the mouth parts of this fly are feeble, adapted to sipping the nectar of flowers, rather than any more serious attack. It is out of the question that they should eat young leaves or the fleshy stems of trees, while it seems to me probable that the injury to peonies and other flowers was due to the attack of the four-lined leaf-bug, or the tarnished plant-bug, well-known pests that blight flower buds and disappear from sight. The injury to the white thorn shrub was pretty certainly due to aphides or plant-lice, which commonly infest the leaves of this shrub. For the eggs of this bibio fly are laid in masses at the surface of the soil, especially in grass lands where there is much decaying vegetation. They hatch into larvæ that feed upon this decaying vegetation throughout their life in this stage. When full grown as larvæ they change to pupæ, and later change again to adult flies. There is but one brood of the flies each year.

The larvæ of this insect are small grayish-brown grubs. They are often found in great masses under boards in grasslands and fence corners. They form the chief food of the robin in early spring.

The unusual abundance of the SQUASH BUG[1] was one of the most notable insect developments of the season. In spring, reports of serious damage began to come in from many regions and they continued well into the summer. Early in the season we began observations upon the pest, together with experiments with methods of combating it, and after his arrival in July, Mr. Conradi, assistant entomologist, made an elaborate study of its life history. The results of these observations and experiments have already been published in Bulletin 89 of this station.

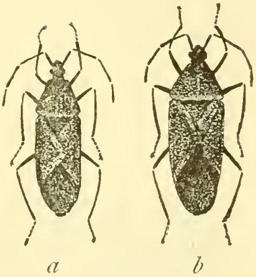

FIG. 2. Squash Bug: *a*, male; *b*, female. Natural size.

The extraordinary severity of this squash bug attack is well indicated in the following letter from Mr. Arthur Smith of Piermont, written July 13:

> We are having a scourge of black squash bugs. I do not know how widespread the pest is, but in this town it is so general that most of the squashes planted and many of the cucumbers have been killed. I can best show the extent of the evil by reporting my own experience. I planted fifteen hills; the plants came up well and I covered them with large screens of netting, as I always have done. I found, however, that the bugs went under the screens and got to the plants even though I had banked up the outside quite carefully. So I took the screens off when the plants were from seven to ten inches high, and depended upon hunting the bugs two or three times a day. I never had any trouble with this method before, but this year it seemed to be of no avail. One day, about two weeks ago, I took off 175 bugs from my vines at noon, and I had picked them clear in the morning, too. It seems to me clearly within bounds to say that I picked 250 bugs from these few hills that day.
>
> There were probably twice as many on that day as on any day before or since, but there has been a steady stream of them flowing from somewhere. One after another my vines have drooped and died till now there are only four or five left out of the sixty or seventy thrifty plants with

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[1] *Anasa tristis* De Geer.

which I started. What seems particularly discouraging is that the work seems to go on just as steadily now that the vines have grown large as it did when they were smaller and more tender. Yesterday two of my plants were killed, one of which was four or five feet long; it was the only stalk left of the hill and exceptionally hardy and stocky. Another vine died which had grown to be eight feet long, with a hard woody vine at the base three-fourths inch in diameter. What is to me particularly puzzling in the case is that I cannot find what especial injury causes the sudden collapse of the plant. A vine which seemed thrifty from end to end, with large, strong, dark green leaves will be found four or five hours later wilted and drooping its whole length. An examination of the stalk near the base will fail to show any especial new injury there. I have used no spray of any sort upon my vines so that no part of the result can be traced to that cause.

I have sometimes wondered whether the bugs are wholly responsible for the mischief. If the vines are left undisturbed after they droop, the part of the stalk below the ground and the root becomes rotten in a few days, but perhaps that is simply because the vine is dead.

This sudden wilting of plants several feet long has attracted the attention of many growers, and been the cause of much discussion. On careful examination one is seldom able to find evidence of the presence of the Squash-vine Borer,[1] a good-sized whitish larva that lives in the stem of the squash plant, nor can one as a rule find any other insects in the stem or the main root. The latter, however, generally shows a decided lack of roots branching off, and its surface is generally more or less roughened as if eaten. A very careful examination of the main root and the ground directly around will generally reveal a slender whitish worm of the general form of Fig. 3. At least this is the creature we have usually found under such conditions, and to which, for the present, we are inclined to attribute the injury named. This pest is the larva of the Striped Cucumber Beetle,[2] which lays its eggs in the ground where squashes and other members of the gourd family are growing. We hope to make a special study of this pest this season.

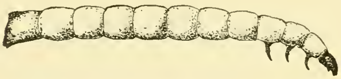

Fig. 3. Larva of Striped Cucumber Beetle

The apple crop of this season was small, as was to be expected from the good crop of the previous year. And as was also to be expected, the comparatively few apples set were badly injured by the attacks of the CODLING MOTH and the PLUM CURCULIO, while in some parts of the state, notably Cheshire county, the APPLE MAGGOT or RAILROAD WORM was extraordinarily destructive. For the first two of these pests spraying every year with arsenate of lead or other arsenical poison is a good remedial measure, but for the third the only method yet devised is that of keeping the fallen apples cleaned up by means of sheep or hogs. And to be effective this must be practised by a whole community.

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[1] *Melittia ceto* Westwood.

[2] *Diabrotica vittata* Fabricius.

The apple trees also suffered an unusual attack from a pest which I have not before known to be destructive in this state —the APPLE LEAF-HOPPER. This is a small greenish-white "fly," which appeared early in the spring upon the under surface of the leaves, sucking out the sap and causing the upper surface to be spotted with white. The drain upon the vitality of the trees must have been quite serious, and is likely to show at least in the smaller size of the fruit the coming season. When adult these leaf-hoppers can fly freely. Their appearance in the stage preceding the adult is shown in the two small creatures on the leaf below the caterpillar in Fig. 4.

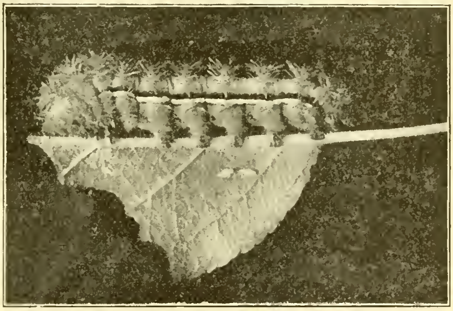

FIG. 4 Young Apple Leaf-Hoppers on leaf below the Caterpillar. Nearly natural size.

In the southern part of the state CANKERWORMS have continued to do serious injury to many orchards. I noticed in those which came under my observation that as usual the birds were doing what they could to check the outbreak. Robins, bluebirds, cedar-birds and many others fed freely upon the pests. A discussion of remedies for these caterpillars has been given in Bulletin 85 of this Station.

An unusual injury to a recently planted orchard was reported from Contoocook by Mr. G. M. Putnam, who sent in September some green caterpillars with the report that young apple trees had been defoliated by them. The larvæ were identified at the United States department of agriculture as a kind known as Green Fruit Worms.[1] These insects are often troublesome in spring by biting holes in young apples, but this injury to foliage in autumn seems not to have before been noticed. Spraying the leaves with arsenate of lead as soon as the injury is seen would doubtless kill the caterpillars.

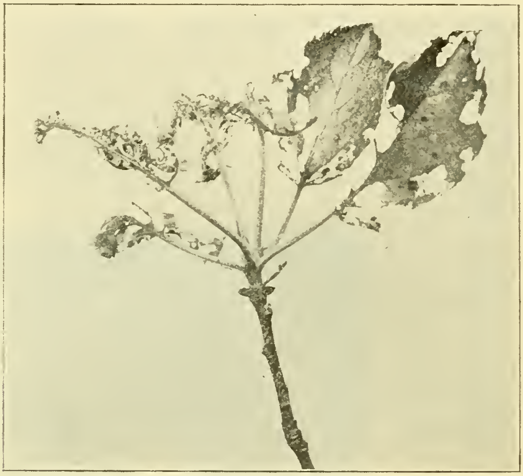

Fig. 5. Apple Leaves Eaten by Cankerworms.

The Bean Weevil[2] continues to do a noticeable injury in many parts of the state. It does not seem to be generally known that these pests will develop brood after brood in stored beans, so that while only a few beans may be affected when the crop is stored away in fall, by the next summer, especially if the beans are kept in a warm room, they may practically all be injured. To prevent this the best method seems to be the enclosing of the beans in a tight vessel in which a little bisulphide of carbon, benzine or gasoline is placed, taking care of course to prevent explosion through contact with fire. Simply keeping the beans in a cold place during the winter will tend to lessen the multiplication of the pests. Late sowing, also, appears to lessen the chances of injury to the crop.

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[1] Some species of *Xylina*.

[2] *Bruchus fabæ* Fitch.

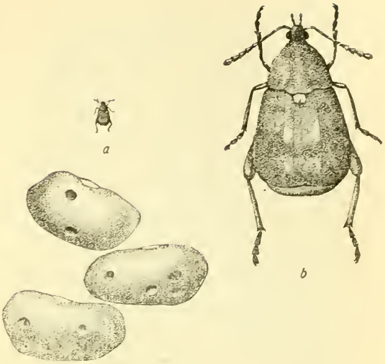

FIG. 6. The Bean Weevil: *a*, natural size; *b*, enlarged; *c*, beans from which beetles have escaped.

Late in May, Hon. Ezra S. Stearns sent from East Rindge leaves of elm infested by an insect which curled the leaves so that they looked like Fig. 7. This malformation is due to the presence of an aphis or plant louse—the ELM LEAF APHIS.[1] Early in spring a small aphid settles upon the under surface of the leaf, sucking out the sap and causing the leaf to become malformed. When full grown she gives birth to living young which develop beside the mother within the curled leaf. There are successive generations until by midsummer there may be hundreds in the colony. The eggs are laid in the crevices of the bark, so that it seems probable that a winter spraying with a rather strong combination of kerosene and water, either in an emulsion with soap or one of the kerowater pumps, would destroy them.

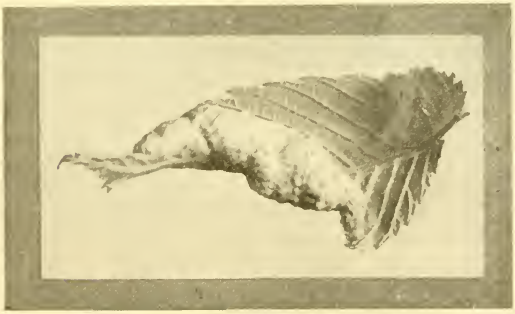

FIG. 7. Elm leaf injured by Aphides.

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[1] *Schizoneura americana* Riley.

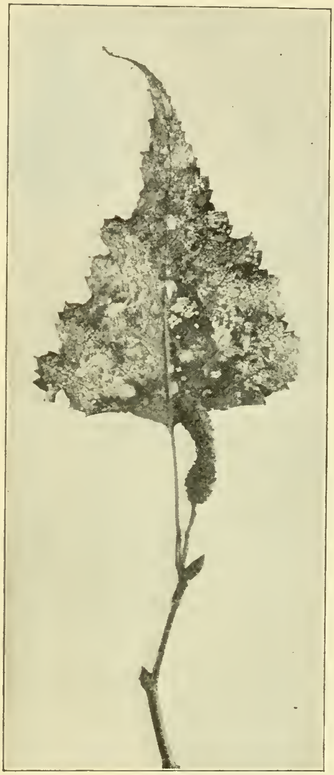

FIG. 8. Birch leaves injured by Skeletonizer, with cocoons.

The BIRCH-LEAF SKELETONIZER [1] mentioned in recent of these records as destructively abundant appears also to be on the wane, though only to a slight extent. The birches in southern New Hampshire showed abundant evidence of its presence, but in the vicinity of Durham, at least, the injury, as a rule, was confined to the upper part of the foliage, and did not extend over the whole tree as heretofore. The FALL WEBWORM,[2] on the other hand, was noticeably more abundant, many trees, especially the ash, being completely defoliated by them.

Miss Caroline G. Soule, to whom I am indebted for many observations upon insect pests, reported that at North Hampton in September she found a Harvest-spider "feeding upon living animal food, a pupa of the tiny Birch-Leaf Skeletonizer." This observation is of special interest, because many naturalists have claimed that these harvest-spiders do not feed upon living insects.

The egg masses of the WHITE-MARKED TUSSOCK MOTH [3] were sent by Mr. Charles W. Morrill, with the statement that they were present in both Nashua and Manchester; specimens were also received from other parts of the state. This is one of those insects which is nearly always present in limited numbers, though it only occasionally becomes seriously destructive. An account of its life history will be found in Bulletin 33 of this station.

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[1] *Bucculatrix canadensiella* Fitch.

[2] *Hyphantria cunea* Drury.

[3] *Orgyia leucostigma* Smith and Abbot.

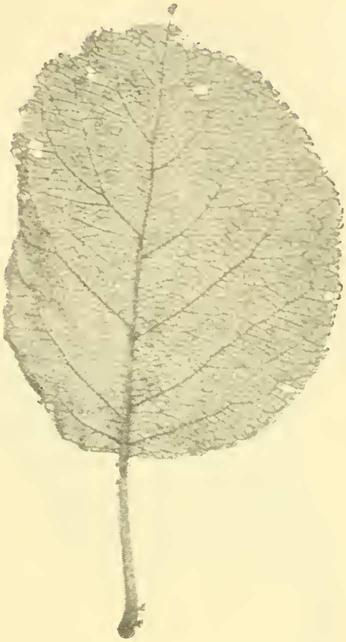

FIG. 9. Apple leaf denuded by Fall Web-worms.

Among the minor injuries reported during the season the following may be briefly mentioned: An injury to strawberry plants at Centre Sandwich by "a greenish worm," probably the strawberry slug;[1] injury to twigs and canes by the eggs of the snowy tree cricket,[2] reported by Mr. J. F. Hobbs; an attack of red spiders[3] on morning-glories and gourds at Piermont, reported by Mr. Arthur Smith; an outbreak of plant lice upon plum trees at Winchester, reported by Dr. A. H. Taft; an injury to raspberry roots at Plymouth, apparently due to nematode worms, reported from Plymouth by Mr. A. T. Atwood; an attack upon grass roots by white grubs,[4] reported from West Rumney by Mr. F. H. Elliott. The various species of grasshoppers seem to have been no more destructive than usual.

THE PESTS THAT MENACE US

New Hampshire has been fortunate during recent years in escaping the attacks of several lately introduced insect pests of first importance, which have ravaged other states. The most notable of these are the elm leaf-beetle, the San Jose scale, the gypsy moth, and the brown-tail moth. The season under consideration has shown that at least one of these pests—the elm leaf-beetle—is already thoroughly established in the heart of the state, far to the northward of where we should expect it to make its first appearance, while I have known for two years that another—the brown-tail moth—had at one time gained a temporary foothold within our borders, though, thanks to the Massachusetts Gypsy Moth Commission, it was apparently destroyed before spreading. We can hardly hope long to escape serious injury from these insects, and it is of the greatest importance to the state that our citizens be on the lookout for the first appearance of each of them.

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[1] *Harpiphorus maculatus* Norton.

[2] *Œanthus niveus* Serville.

[3] *Tetranychus*—sp.

[4] *Lachnosterna*—sp.

For several years there has been reason to expect that the Imported Elm Leaf-Beetle,[1]—which has been so troublesome in other states, would attack the elm trees along our southern borders, although there seemed to be some reason to hope that it would not flourish in the central and northern parts of the state. It was something of a surprise, therefore, to receive from Conway Centre larvæ of

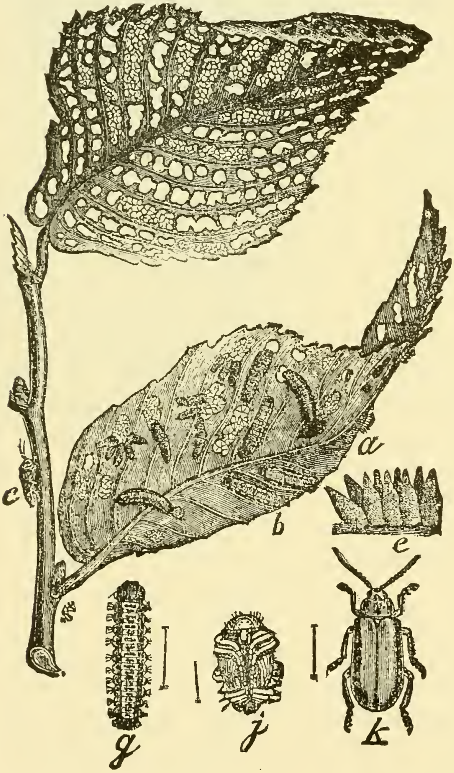

Fig. 10. Elm Leaf-Beetle: *a*, eggs; *b*, larvæ: *c*, beetle; all natural size; *e*, eggs; *g*, larva; *j*, pupa; *k*, beetle; *e* to *k* magnified. (After Riley.)

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[1] *Galeruca xanthomelæna* Schrank.

this pest, with the report that they had been at work upon an elm tree for at least two seasons. To make sure of the identification, the specimens were sent to Dr. L. O. Howard, entomologist of the United States Department of Agriculture, who said that they were undoubtedly the imported elm leaf-beetle. If this insect can successfully establish itself in the White Mountain region, I can see no reason why it should not become a pest in all parts of the state to the southward. Consequently, I hope that our citizens will promptly notify the station of any attack upon elms, that we may determine whether the pest is at work in other regions. From reports of injury to elm leaves in Concord and neighboring towns I should not be surprised to find the pest already at work in central New Hampshire.

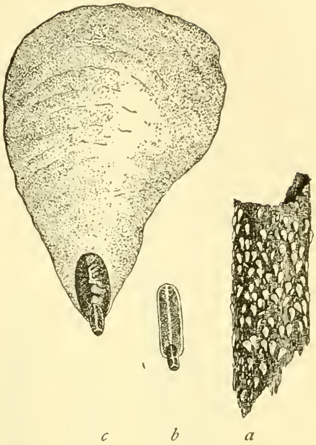

FIG. 11. The Scurfy Scale: *a*, bark showing scales in position, natural size; *b*, male scale, magnified; *c*, female scale, magnified.

Another insect which our northern latitute has given us some hope of escaping is the notorious SAN JOSÉ SCALE.[1] And as yet I have found no evidence of its presence within our borders. There is imminent danger of its introduction, however, and it seems to me that at least along the southern coast region in the east, and the Connecticut river in the west, it would be likely to flourish if it gained a foothold, while it is by no means safe to assume that it would not develop extensively in other parts of the state. It behooves every one, therefore, in buying trees and plants from outside the state, to accept only fumigated stock, certified free from pests. We have no law upon this subject as have other states: this makes care on the part of individuals all the more necessary. That our fruit growers, fortunately, are watching for this pest is shown by the receipt by the station this year, as in previous seasons, of our common apple-tree bark-lice, with the query as to whether they were the San José scale. These bark-lice are represented in the accompanying pictures.

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[1] *Aspidiotus perniciosus* Comstock.

The gray or brown Oyster Shell Bark-louse[1] gets its name from its resemblance to a miniature oyster shell: by this fact it may be recognized. The whitish Scurfy Bark-louse[2] (Fig. 11) is shorter and broader, with a triangular outline. This distinguishes it from the San José scale, which is round. But in case of doubt regarding any scale upon trees or vines, it should be sent to the station for critical examination.

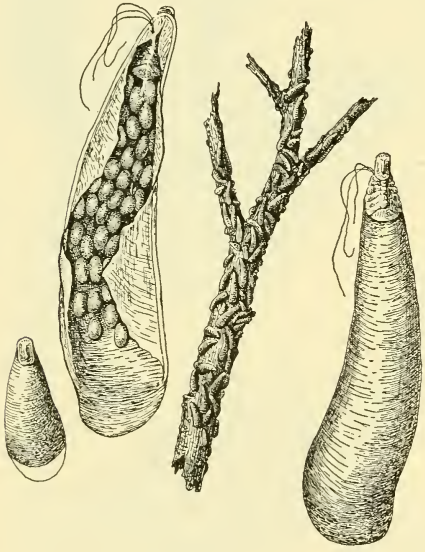

Fig. 12. Oyster-shell bark-louse: *a*, scales on apple twig; *b*, female scale, back view, magnified; *c*, female scale and eggs, under-side, magnified; *d*, male scale, magnified.

On the whole perhaps the Brown-Tail Moth[3] is the one of these pests which at present should receive the most serious consideration. This insect is already well established in many towns in Massachusetts, where it is exceedingly troublesome. For it not only destroys the foliage on a great variety of trees, but it also produces a serious affection of the skin in people who come in contact with the barbed hairs of the caterpillars. These hairs are very generally scattered in localities where the insects are abundant, as

[1] *Mytilaspis pomorum* Bouché.

[2] *Chionaspis furfurus* Fitch.

[3] *Euproctis chrysorrhœa* Linne.

the cast skins of the caterpillars are blown hither and thither by the wind.

In the summer of 1899 there was a severe gale along the coast during the time when the adult brown-tail moths were flying. It was believed by the authorities of the Massachusetts Gypsy Moth Commission, notably the entomologist, Mr. A. H. Kirkland, who studied the matter carefully, that this storm distributed the moths along the coast northeast from the vicinity of Boston at least as far as Seabrook, New Hampshire. In December, 1899, the winter nest of this insect illustrated on the title page of this bulletin was taken at Seabrook by Mr. F. C. Moulton, the photograph being sent us by Mr. Kirkland. The Gypsy Moth Commission did what they could to exterminate the pest in the place where it was found. But that the moth is now present within our borders is shown by the fact that one of the adult moths was taken at Hampton last summer by Mr. S. A. Shaw.

The young caterpillars of this species pass the winter in nests of rolled leaves attached to the twigs of the food-plant. An idea of the appearance of these winter nests may be obtained from the picture on the title page of this bulletin.

It is too much to expect, that we shall long escape the general presence of the pest, and every citizen should be on the watch for its first appearance. It is thoroughly established over a large area in Massachusetts near our borders: it may be blown to us by the wind or brought to us by teams, electric cars, or railroad trains. Any time in fall, winter, or spring when one can find upon a tree a curled leaf containing a host of tiny caterpillars, the significance of the fact should be fully realized. For it is probably a colony of these pestiferous insects: the leaf securely packed in a tight tin box, without air holes, should be sent to the station with a full statement regarding the finding of it. All others of the nests should be promptly burned.

The state of Massachusetts has practically abandoned its heroic fight against the GYPSY MOTH,[1] and it seems to be only a question of time when this notorious pest will invade our borders. When it spreads over our forests we are likely to get a new idea of the possibilities of the damage which may be caused by insects. So here again we should be on the lookout constantly for any hairy caterpillars heretofore unknown, which may be found feeding upon the leaves of any sort of tree. If such specimens are sent in a tight box to this station, they will be promptly identified. The necessity of such identification was clearly shown during the summer when the newspapers reported an outbreak of the gypsy moth at Nashua. Direct inquiry brought out the fact the statement was founded upon a mistake, there being no gypsy moths present.

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[1] *Ocneria dispar* Linné.

This peculiar danger in which New Hampshire now stands from these pests without our borders renders it especially desirable that unrecognized insects of all sorts be sent this Station for identification. This is one of the things for which the Station exists, and the public is cordially invited to send specimens and make inquiries freely. In sending specimens enclose them in a tight box with a little of the food-plant. There is no necessity for punching air-holes in the box. Address them simply to Experiment Station, Durham, New Hampshire.

Bulletin 91 May, 1902

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

Killing Woodchucks with Carbon Bisulphide

BY CLARENCE M. WEED

Much damage is done to various crops every year by the common woodchuck or ground hog. Many ways of exterminating these animals have been devised, but on the whole the simplest and most satisfactory method is that of the use of bisulphide of carbon, an inflammable liquid which on exposure to air volatizes into a vapor that is very destructive to animal life.

This substance has been in use for several years for destroying ground squirrels in the Western states, and has also been largely used for killing insects in mills and factories. It has often been recommended and utilized to destroy woodchucks, but its merits for this purpose do not seem to be very generally appreciated.

It is the purpose of this brief bulletin to record a series of experiments, covering several seasons, in the use of carbon bisulphide as a woodchuck exterminator. The experiments have been carried on with the help of Messrs. A. F. Conradi, W. F. Fiske, and R. A. Cushman, as well as of Mr. Percy A. Campbell, who has reported the results of his work in another part of the state.

One special advantage of carbon bisulphide is that its vapor is more than twice as heavy as air, so that in a woodchuck burrow it will follow along the hole until it reaches the bottom, crowding the air above it to the top. As the animal is likely to be in the lower part of the burrow it is almost certain to inhale the poisonous vapor and be killed.

THE SERIES OF EXPERIMENTS

Our first experiments in the use of bisulphide of carbon for killing woodchucks were made in 1897 when Mr. Fiske treated a number of holes with the substance. So far as known the results were all successful. In one case the burrow was dug out and a large woodchuck was found dead in a circular chamber, about five feet from the mouth of the burrow and two feet below the ground vertically. In another case a mouse hole connecting with a woodchuck burrow which had been treated with the bisulphide was dug out and three white-bellied field mice were found dead, showing that the poisonous vapor had followed along the comparatively small burrow of the mouse.

In 1898 a few more experiments were made, an ounce of the liquid being poured upon a wad of old burlap loosely wound around the end of a stick in such a way that when the stick was pushed down into the burrow and then withdrawn the burlap would remain in the hole. The holes, of course, were stopped up and two days later they had not been opened, so that it was pretty sure that the animals were dead inside, as there was evidence of their having been, very recently, present.

In 1899 experiments were continued by Mr. R. A. Cushman with similar successful results. On July 27 a hole was treated at 9:30 a. m. with two-thirds of an ounce of bisulphide of carbon just after a woodchuck had been seen to enter it. The afternoon of the next day the hole had not been uncovered, so that it was safe to assume that there was a dead and buried woodchuck within it.

Another burrow having two entrances was treated the morning of July 27 with about an ounce of bisulphide. At 2 p. m. the next day neither entrance had been uncovered. A third burrow having three entrances treated at the same time with nearly an ounce of bisulphide to each entrance had not been uncovered when visited on the afternoon of the next day. A fourth burrow having four entrances was treated at 10 a. m. July 27, nearly an ounce of the liquid being used in each entrance which was, of course, covered with earth immediately after treatment. At 2 p. m., July 28, none of the entrances had been uncovered.

On July 29, 1899, two burrows were treated; one having only one entrance was covered at 9:30 a. m. after treatment with one ounce of bisulphide of carbon. Two days later at 2 p. m. it had not been uncovered. Still another of much the same sort was treated in like manner and with like result.

In 1901 no particular experiments were made at Durham, but through the kindness of one of our students, Mr. Percy A. Campbell, I am able to give the following results of some work in this line done at Litchfield, N. H. Mr. Campbell's report is as follows:

"The first day that I killed woodchucks with carbon bisulphide was in the last of June before the grass had been cut, so that there were a few holes which I did not find. I started out with a small can of carbon bisulphide, some old cotton in my pocket, a handle basket, and a shovel. I began on one side of the field and treated every hole that I came to. I first filled the basket with dirt and set it above the hole ready to turn in; then taking a small piece of cotton which I could hold easily between my thumb and finger I poured upon it just enough carbon bisulphide to saturate it. Then I threw this into the hole as far as possible and immediately poured in the dirt and filled the hole up even with the surface. If there was more than one entrance to the burrow I always filled in all but one before the treatment. Several holes were in the river bank and some in the grass land. In each of three cases I saw woodchucks go into the burrow just before I treated it; none of these was dug open afterward. Out of about twenty-five burrows that I treated that afternoon, all of which gave evidence of having been recently used by woodchucks, only two or three were dug open and these apparently had been burrowed into from the outside rather than opened from the inside, as the earth was thrown back away from the holes.

"After the grass was cut I followed up this treatment as fast as untreated holes were found, with the result that by the latter part of August hardly an open burrow could be found upon the farm and it was very seldom that a woodchuck was seen.

"One day I found a burrow with two woodchucks in it. Filling up one of the outlets I put the bisulphide in the other with the result that the holes were never reopened.

"On another farm a short distance from home I treated about twenty burrows one day after haying. I did not visit all the holes again, but so far as I know none of them was reopened. This method not only kills the old woodchucks but it also destroys in a humane way the young in the burrow. It has, too, the additional advantage that the animal is not only killed but he is buried and the hole is filled so that considerable time is thus saved."

In 1902 experiments were begun early in April and continued for several weeks, the results in all cases being apparently successful. More than a dozen burrows were treated by Mr. Conradi with the bisulphide of carbon, an ounce or more of the liquid being used for each burrow. These burrows were in all sorts of situations, some of them on open hillsides, others along the borders of woods, and others in meadows. Only in two instances were the holes reopened after treatment, and in each of these cases there was conclusive evidence that they had been opened from the outside by woodchucks burrowing into them.

PRECAUTIONS TO BE OBSERVED

It should be distinctly understood by every one who uses carbon bisulphide for any purpose that it is *highly volatile*, *inflammable*, *and poisonous*. When mixed with air it is also *highly explosive*. Any reasonable care in its use out of doors, however, can lead to no ill results. Used as recorded in the above experiments there is no necessity for one to inhale the vapor, and a small quantity in a glass-stoppered bottle may be safely stored away in a cool place without danger. Of course it must be kept out of the reach of children and away from fire of any kind. The one who applies it to woodchuck burrows must not be smoking while handling the liquid. For most people it is probably better to buy of the local druggist a small quantity at a time, in which case it should not cost more than twenty-five or thirty-five cents a pound, than to have to store a larger amount. The ordinary commercial carbon bisulphide will do as well for this purpose as that which is chemically pure.

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NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

SILAGE STUDIES

BY FRED W. MORSE

Some of the early bulletins of this station* treated the subject of silage, and for the past ten years the department of chemistry has had it for one of its lines of investigation. The following phases of the question have from time to time occupied its attention: Differences between varieties in composition and feeding value, effect on composition of various quantities of seed per acre, the composition of the crop at different stages of growth, and the changes in composition of the fodder while in the silo.

COMPOSITION OF THE CROP AT DIFFERENT STAGES OF GROWTH.

This phase of the subject has received much attention from our experiment stations,† and the results are strikingly uniform.

The results here tabulated were obtained in connection with another problem pertaining to the corn crop; but make an excellent illustration of the progressive changes in the corn plant as it matures. In 1891, at Hanover, a number of plots were planted by the department of agriculture with different varieties of corn, and with various quantities of seed per acre. The corn was cut at intervals during the season, weighed and sampled, and the samples dried by hanging in the loft of the barn.

* Bulletins 2, 3, and 14.

† Cornell Univ. Agri. Expt. Sta., Bull. 135. N. H. Expt. Sta., Bull. 3. N. Y. Expt. Sta., 8th Ann. Rept. Vt. Expt. Sta. Rept., 1892. Penn. Expt. Sta. Rept., 1888. Maine Expt. Sta. Rept., 1893.

By the time this portion of the work was done, the plans and labor incidental to the removal of the institution from Hanover to Durham, rendered it necessary to curtail the analytical work to one variety of corn, at four stages of growth and from four plots, each with a different quantity of seed.

The variety was the Sanford, which had shown itself to be best suited to that locality.

As will be shown later, the various quantities of seed had comparatively little effect on the composition, consequently for showing the changes during growth, the results from the four samples taken at each stage are averaged in the following table:

COMPOSITION OF SANFORD CORN AT DIFFERENT STAGES.

STAGE OF GROWTH.	Green.		Absolute Dry Matter.				
	Water.	Dry Matter.	Ash.	Protein.	Fiber	Soluble Carbo-hy-drates.	Fat.
Aug. 5. Tassels but no silk …	90.83	9.17	8.54	14.40	33.08	42.33	1.65
Aug. 28. Tassels and silk fading……	87.66	12.34	6.13	10.82	28.99	52.35	1.71
Sept. 2. No notes given…….	84.56	15.44	5.11	9.69	26.43	56.93	1.84
Sept. 7. Some ears at roasting stage……	84.51	15.49	4.27	9.69	23.84	60.18	2.02

The samples were cut and weighed, and the field notes made by Mr. D. E. Stone, then assistant in agriculture. The amount weighed from each plot was that cut from a measured rod of drill. The comparative yields of fodder, dry matter and most important constituents, are as follows:

POUNDS OF SANFORD FODDER AND CONSTITUENTS AT DIFFERENT STAGES, CUT FROM ONE ROD OF DRILL.

STAGE OF GROWTH.	Fodder.	Water.	Dry Matter.	Protein.	Fiber.	Soluble Carbo-hy-drates.
Aug. 5. Tassels but no silk…………	40.5	36.8	3.7	.53	1.22	1.57
Aug. 28. Tassels and silk fading……	58.	50.8	7.2	.78	1.99	3.77
Sept. 7. Some ears at roasting stage	55.	46.5	8.5	.82	2.03	5.12

There are two facts which must be emphasized in this comparison, the greatest weight of fodder was obtained at the time the plant was in full bloom ; but the most dry matter and essential nutrients, protein and soluble carbohydrates, were in the most mature corn, in this instance, at the roasting-ear stage.

In the earliest stages of growth the plant consisted largely of water and fibre, and had not reached its maximum size.

In other words, one will get the most tons of green fodder when the corn is in full bloom ; but it would take one and one third tons at that stage to be equal to one ton of the fodder cut at the stage when the kernel is full. A field would have to yield sixteen tons per acre in one case and twelve tons in the other. This is of fundamental importance in the selection of varieties of corn for silage. It has been tried by several stations and with the same result. A variety of corn which does not reach the stage of fairly well filled ears is unprofitable from the standpoint of yield of actual food material.

COMPARISON OF VARIETIES OF CORN FOR SILAGE.

The removal of the experiment station to Durham, in the southeastern part of the state, made this question a practical one since the corn season was, on the whole, somewhat longer than at Hanover.

In 1895, '96, and '97 three typical varieties of corn were planted for silage, viz., Sanford, Leaming, and Mosby's Prolific.

The Sanford is well known throughout the state, but it is not amiss to say briefly that it is a white flint variety, growing about eight feet high, with an abundance of foliage and developing large ears.

The Leaming is also well known as a yellow dent variety, grows with us about ten feet high on the average, and develops a large ear which generally reaches either the dough or glazing stage at our usual time of cutting, the second week in September.

Mosby's Prolific is a typical Southern corn, grows about twelve feet tall, and barely reaches the stage of tassel and silk.

With regard to the yields of the different varieties much depends on whether we take as a basis figures from large areas or from small plots. Data gathered from the notes of the agricultural department covering different seasons, show that Sanford on plots has yielded at the rate of fifteen tons per acre in one experiment and twenty-one tons in another, while the Leaming has under like conditions produced twenty-nine tons per acre. On a field scale, in our most favorable location, five acres have borne an average of ten tons per acre of Sanford corn and thirteen tons of Leaming. It is safe to say that Leaming has produced one fourth more green fodder than Sanford. The Mosby has not produced more fodder than the Leaming in our trials, and has not been extensively planted.

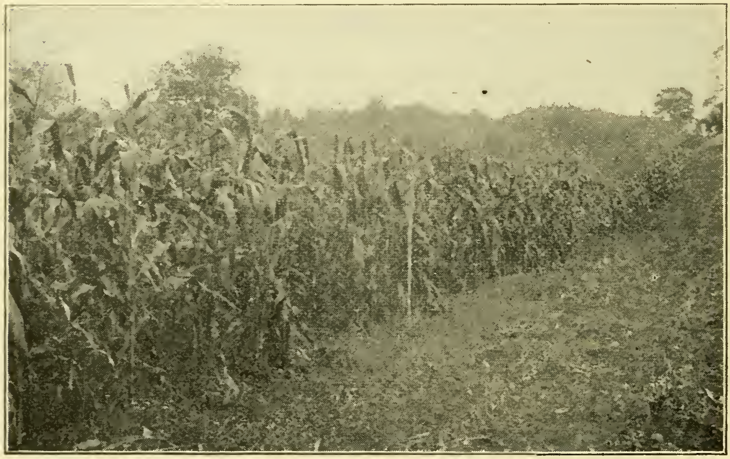

FIG. 1 —Field of Sanford Corn. Average height, 8 feet.

The comparative values of the three varieties as silage was determined in 1896 and 1897 by studying the effect on milk production. In this work we had the coöperation of the agricultural department, and the feeding was supervised by Mr. R. S. Alden, superintendent of the farm. This study was conducted under conditions which would be encountered in actual farm practice. It was not possible to have the different varieties of silage fed to several groups of animals simultaneously, and neither was there sufficient help to weigh the food to individual animals. Consequently the different materials for the rations were weighed for the group, and the feeder distributed them among the individuals according to his judgment. Milk records were kept for the individual animals. In the course of the experiment, if an animal dropped out of a group from any cause, as almost always happens, the amount of food which she received was weighed and deducted from the ensuing daily rations for the group. At the end of the experiment the milk records of the individual cows which completed the trial were footed and averaged for the different periods.

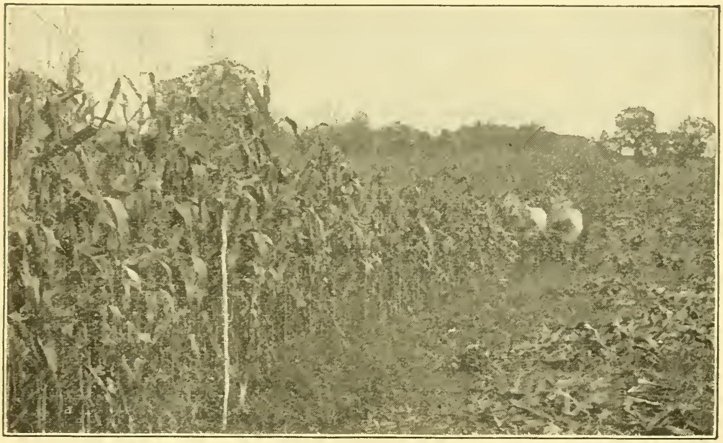

FIG. 2.—Field of Leaming Corn. Average height, 10 ft. Cutting with corn harvester.

In 1896 there were nine cows in one group only, virtually a small herd. Their rations were as follows: From Jan. 29 to Feb. 18, 375 lbs. Sanford silage, 60 lbs. hay, 45 lbs. Buffalo gluten feed, 17½ lbs. linseed meal.

From Feb. 19 to March 4, Leaming silage instead of Sanford.

From March 4 to 10, 400 lbs. Leaming silage, 60 lbs. hay, 28 lbs. middlings, 24 lbs. Buffalo gluten feed, 16 lbs. linseed meal.

From March 10 to 31, Mosby silage instead of Leaming.

From April 1 to 21, Sanford silage instead of Mosby.

The increase in the ration on March 4 was made because the animals appeared to be losing flesh slightly, although their milk yields remained normal. It was found that they readily ate the additional food; but it had no perceptible effect on the quantity of milk. Withholding it, however, might have resulted in a more rapid daily shrinkage.

For the first three periods the average daily yield per cow was as follows:

Sanford, ending Feb. 18, 21 days, average yield, 20.8 lbs.
Leaming, ending March 10, 21 days, average yield, 19.2 lbs.; average shrinkage, 1.6 lbs.
Mosby, ending March 31, 21 days, average yield, 16.8 lbs.; average shrinkage, 2.4 lbs.

One cow was dropped from the group for the fourth period, and consequently the average yield for the group could not be calculated for the closing period with Sanford silage. Therefore, the records of a sub-group of four cows, representing different stages of lactation at the beginning of the first period and continuing throughout the four, were computed for a secondary comparison, which gave these results as the average daily yield per cow:

Sanford, ending Feb. 18, 21 days, average yield, 26.1 lbs.
Leaming, ending March 10, 21 days, average yield, 24.1 lbs.; average shrinkage, 2.0 lbs.
Mosby, ending March 31, 21 days, average yield, 21.3 lbs.; average shrinkage, 2.8 lbs.
Sanford, ending April 21, 21 days, average yield, 20.4 lbs.; average shrinkage .9 lbs.

Subtracting the daily average of one period from that of the period preceding it, gives the daily rate of shrinkage of one period compared with another.

The results indicate the inferiority of Mosby silage; but are not decisive with respect to the comparative merits of Sanford and Leaming, although two pounds of milk per day is large for an average shrinkage.

In 1897 the comparisons were repeated in a similar manner, but with four different groups of cows with respect to the weighing of rations. One grain mixture was used throughout the winter, but changes were made from time to time in the dry fodder. These changes are neglected in the comparison, since they were the common coarse fodders of the farm, with no clover to introduce marked variations in protein. The grain consisted of,—

100 lbs. wheat middlings, 50 lbs. wheat bran.
100 lbs. Buffalo gluten feed, and 150 lbs. cotton-seed meal.

The groups of cows which continued throughout four periods were as follows :

Group A. Three Ayrshires.
Ration : 120 lbs. silage, 21 lbs. dry fodder, 26 lbs. grain.
Group D. Three Durhams and one Holstein.
Ration : 160 lbs. silage, 28 lbs. dry fodder, 32 lbs. grain.
Group J. Five Jerseys and one Guernsey.
Ration : 210 lbs. silage, 40 lbs. dry fodder, 54 lbs. grain.

The different varieties of silage were fed during these periods in the following order :

Mosby's Prolific, Jan. 16 to Feb. 3, 19 days.
Sanford, Feb. 4 to Feb. 25, 22 days.
Leaming, Feb. 26 to March 23, 26 days.
Sanford, March 24 to April 13, 21 days.

A group of three new milch cows (Group N), two Ayrshires and one Jersey, was fed from Feb. 26 to April 13, or two periods, with a daily ration of 120 lbs. silage, 21 lbs. dry fodder, and 30 lbs. grain.

Group D continued but seven days in the fourth period, and Group J stopped at the end of thirteen days.

The average daily milk yield per cow for each period with the different groups is shown in the following statement, together with the average daily shrinkages :

GROUP A.

Mosby, 19 days, average yield, 27.5 lbs.
Sanford, 22 days, average yield, 25.5 lbs.; average shrinkage, 2.0 lbs.
Leaming, 26 days, average yield, 22.9 lbs.; average shrinkage, 2.6 lbs.
Sanford, 21 days, average yield, 20.9 lbs.; average shrinkage, 2.0 lbs.

GROUP D.

Mosby, 19 days, average yield, 17.1 lbs.
Sanford, 22 days, average yield, 17.1 lbs.; average shrinkage, nothing.
Leaming, 26 days, average yield, 15.4 lbs.; average shrinkage, 1.7 lbs.
Sanford, 7 days, average yield, 15.4 lbs.; average shrinkage, nothing.

GROUP J.

Mosby, 19 days, average yield, 18.3 lbs.
Sanford, 22 days, average yield, 17 lbs.; average shrinkage, 1.3 lbs.
Leaming, 26 days, average yield, 16.1 lbs.; average shrinkage, .9 lbs.
Sanford, 13 days, average yield, 16.1 lbs.; average shrinkage, nothing.

GROUP N.

Leaming, 25 days, average yield, 35.7 lbs.
Sanford, 21 days, average yield, 33.1 lbs.; average shrinkage, 2.6 lbs

The results with the different groups are very similar to those of the previous year. In passing from Mosby silage to Sanford there is slightly less shrinkage than when the cows passed from Leaming to Sanford, but there is little choice in the two dent varieties this season. Comparing Sanford and Leaming, it must be seen that Sanford was a little superior. Nevertheless the changes from Sanford to Leaming were earlier in the periods of lactation of the animals than the changes from Leaming to Sanford, and in the more productive periods of lactation the rate of daily shrinkage is higher than in the less productive stages. A simultaneous feeding of the different varieties would be more precise, but hardly more definite. A comparison of the chemical composition of the varieties of silage is given in the table opposite.

The average composition of the three varieties of silage varies a little. The Sanford is a little the best while the Mosby's Prolific is the poorest.

The mixture of corn and soy beans and corn and clover are interesting. The former mixture consisted of two parts of corn and one part of soy beans, cut and packed together. The latter mixture was approximately equal parts of corn and second-crop clover. Such mixtures improve the silage by increasing the protein and lessening the necessity for grain. In the case of soy beans, it is practically necessary to store them in the silo, but it is not to be recommended for clover, when the season will permit thorough drying.

COMPOSITION OF VARIETIES OF CORN SILAGE.

Variety.	Water.	Ash.	Protein.	Fiber.	Soluble Carbohydrates.	Fat.
Sanford, 1891, Hanover, 1	82.24	1.04	1.82	5.02	9.32	.56
Sanford, 1894, Durham, 1	80.66	1.39	1.54	5.14	10.74	.53
Sanford, 1896, January-February average	79.13	1.33	1.92	5.08	11.89	.65
Sanford, 1896, April average	79.37	1.48	1.73	5.10	11.19	1.13
Leaming, 1896, February-March average	80 20	1.60	1.70	5.49	10.62	.39
Leaming, 1898, April 1	80.58	1.04	1.03	5.83	11.04	.48
Leaming, 1898-1899 average	81.16	1.59	1.79	4.98	9.95	.53
Leaming, 1899-1900, average	83.62	1.59	1.35	4.68	8.24	.52
Mosby's Prolific, 1896, 1	78.67	1.83	1.98	7.02	9.78	.72
Mosby's Prolific, 1897, 1	80.74	1.69	1.35	6.97	8.66	.59
Average of Sanford	80.35	1.31	1.75	5.09	10.78	.72
Average of Leaming	81.39	1.45	1.47	5.24	9.97	.48
Average of Mosby's Prolific	79.71	1.76	1.66	7.00	9 22	.65
Sanford corn and Soy bean, 1897	79.17	2.07	2.82	6.41	8.31	1.22
Leaming corn and red clover, 1898	71.40	2.16	3.25	7.71	14.50	.88

EFFECT OF DIFFERENT QUANTITIES OF SEED.

The first trial in this line was at Hanover in 1891, as already mentioned, with Sanford corn. The quantities of seed used per acre were one bushel, one half bushel, twelve quarts, and ten quarts. The corn on each plot was cut at four different stages of growth, and the amount from a measured rod of drill weighed and sampled. From the notes of the assistant in agriculture have been obtained the weights of each lot and the number of stalks per rod.

In making the comparison the tabulated data have been limited to an average of the results for each quantity of seed obtained in the last two stages of growth, which were but five days apart. It is of interest to know how thickly plants will be placed when a certain quantity of seed is used. In this experiment the four different lots where 32 quarts of seed were used varied from 57 stalks to 87 stalks; 16 quarts of seed gave from 32 to 44 stalks ; 12 quarts, from 26 to 35 ; and 10 quarts, from 27 to 34 stalks. One bushel of seed gave an average of 72 stalks to the rod, one half bushel 37 stalks, 12 quarts 32 stalks, and 10 quarts 30 stalks.

The composition of the corn from each quantity of seed averaged from two cuttings is in the table below.

COMPOSITION OF SANFORD CORN FROM DIFFERENT QUANTITIES OF SEED.

Amount of seed per acre.	Pounds of fodder per rod of drill.	Green.		Absolute Dry Matter.				
		Water.	Dry Matter	Ash.	Protein.	Fiber.	Soluble Carbohydrates.	Fat.
1 bush.	61	83.97	16.03	5.15	9.60	25.13	58.36	1.76
½ bush.	50	84.30	15.70	4.30	8.80	25.81	59.13	1.96
12 qts.	54	84.93	15.07	5.02	10.72	24.43	57.82	2.01
10 qts.	50	84.94	15.06	4.97	9.63	25.17	58.22	2.01

In this comparison the variations in composition are slight, and the field notes make no mention of any differences in development other than in yield of green fodder This difference in yield was 20 per cent. in favor of the bushel of seed, and follows throughout the constituents.

In 1897 a somewhat similar experiment was conducted at Durham with Leaming corn. Through one field, that season, duplicate pairs of rows were planted by the corn-planter, at the rate of one half bushel, one bushel, and two bushels respectively per acre. In the fall the most uniform portions of these rows were cut and weighed at the usual time of harvesting for the silo, and samples taken for analysis. The yields of fodder have been taken from the notes of the agricultural department, at that time in charge of Professor Rane. The effects of the different quantities of seed on composition and yield follow :

COMPOSITION OF LEAMING CORN FROM DIFFERENT QUANTITIES OF SEED.

Amount of seed per acre.	Yield per plot.	Green.		Absolute Dry Matter.				
		Water.	Dry Matter	Ash.	Protein.	Fiber.	Soluble Carbohydrates.	Fat.
½ bush.	1267	77.15	22.85	4.17	8.52	20.77	64.37	2.17
1 bush.	1840	78.84	21.16	4 80	7.12	23.17	62.38	2.53
2 bush.	1925	74.05	25.95	5.56	4.70	25.27	62.53	1.94

The quality of fodder from the two-bushel rows is much inferior to either of the others in composition, lacking especially in the protein and containing an increased proportion of fiber. The quality of the fodder from the bushel-rows was a little inferior to that of the half-bushel rows, but the yield of fodder was nearly 50 per cent. more, giving an increase in both protein and carbohydrates for the total crop.*

CHANGES IN THE COMPOSITION OF CORN FODDER WHILE IN THE SILO.

This subject has occupied our attention for several successive seasons, and has required the analysis of samples of green fodder as it was put into the silo and of silage as taken out.

Samples were taken in connection with the electrical temperature measurements made by Dr. Lamson, partially reported in Bulletin 79. The samples of fodder and of silage were from the immediate vicinity of the various electrodes, thus insuring that both green fodder and silage represented the same lot of corn.

These comparisons were made in two successive years, with the following average results for each year:

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* See, also, Me. Expt. Sta. Repts., 1894, '95, and '96. Kansas Expt. Sta., Bull. 45. Minnesota Expt. Sta., Bull. 50.

	Green.		Absolute Dry Matter.				
	Water.	Dry Matter.	Ash.	Protein.	Fiber.	Soluble carbohydrates.	Fat.
Green fodder, 1898.	80.50	19.50	7.59	8.97	27.24	53.77	2.43
Silage, 1898–1899	81.75	18.25	9.16	9.93	26.56	51.93	2.42
Green fodder, 1899.	81.14	18.86	7.07	9.20	22.33	59.61	1.79
Silage, 1899–1900	83.62	16.38	9.34	8.15	28.92	50.34	3.25

In 1898–1899 the changes were not very marked, but in 1899–1900 they were noticeable and important, since they occurred mainly in the carbohydrates, *i. e.*, the fiber and soluble carbohydrates, the former apparently increasing and the latter losing. There is a loss in dry matter, which is mainly due to the destruction of soluble carbohydrates.

A study of these carbohydrates has shown that this destruction is confined almost exclusively to the sugars occurring in the corn-plant. The results of determinations in three different seasons show the following percentages of sugar in the dry matter of the fodder as put in the silo, and of the silage as taken out:

AVERAGE PERCENTAGES OF SUGAR IN DRY MATTER.

1898–1899.		1899–1900.		1900–1901.	
Fodder.	Silage.	Fodder.	Silage.	Fodder.	Silage.
7.75	0.20	20.89	0.51	8.24	0 55

The starch was apparently affected little, if at all. We have but one year's results on this. In 1898 four samples of fodder gave an average of 3.06 per cent. starch in dry matter, and the two samples of corresponding silage showed 3.17 per cent.

This action on sugar is of much practical importance in its bearing upon the period of growth at which to cut corn for the silo.

The amount of sugar has been found to vary widely in different seasons, which is due in a measure, if not wholly, to the different stages of maturity at which corn will be when cut. These periods must necessarily vary with different years if the cutting is fixed by date instead of by the maturity of the crop. It is not possible as yet to state at just what period of growth corn contains most sugar, but it is somewhere between the formation of the ear and the milk stage.*

As the ear ripens the sugars change to starch in the kernels, and decrease in the stalk and leaves.

PERCENTAGES OF SUGARS OBTAINED IN DIFFERENT YEARS. CALCULATED TO DRY MATTER.

		Variety.	Dry Matter.	Sugars.
1897.	16 qts. per acre.	Leaming.	22.85	17.59
	32 qts. per acre.	Leaming.	21.16	21.17
	64 qts. per acre.	Leaming.	25.95	21.15
1898.	Sept. 12.	Leaming.	18.69	8.36
	Sept. 13.	Leaming.	20.31	6.07
	Sept. 15.	Leaming.	18.49	8.41
	Sept. 15.	Leaming.	21.47	
1899.	Sept. 1.	Leaming.	19.03	22.47
	Sept. 5.	Leaming.	19.95	16.46
	Sept. 8.	Leaming.	17.76	21.53
	Sept. 19.	Leaming.	15.90	23.10
1900.	Sept. 8.	Leaming.	18.91	10.66
	Sept. 13.	Leaming.	24.43	8.51
	Sept. 15.	Leaming.	16.80	5.55
	Immature.	Leaming.	15.84	7.38
	Medium.	Leaming.	16.93	9.07
	Mature.	Leaming.	24.14	8.04
	Mature.	Sanford.	25.07	7.94
	In silk.	Eureka.	18.10	11.37
	Tasselled.	Prehistoric.	14.21	8.90

Cutting corn for the silo at the period of growth yielding the most sugars results in larger losses in the silo, since the shrinkage in dry matter in 1899–1900 was much greater than in 1898–1899 or 1900–1901.

	1898-1899.		1899–1900.		1900–1901.	
	Fodder.	Silage.	Fodder.	Silage.	Fodder.	Silage.
Dry matter,	19.50	18.25	18.86	16.38	20.05	19.52
Sugar in dry matter,	7.75		20.89		8.24	

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* See, also, Me. Expt. Sta. Rept., 1893.

CONCLUSION.

Our results and those of other stations invariably agree that the best silage is obtained from corn that has nearly reached maturity, with ears fully formed and well filled. At this stage of growth, also, a corn plant has reached its maximum of food production. Varieties of corn should be selected which yield the largest crops at this stage, rather than those which produce large plants, but are yet immature at cutting time. This practice is already followed by many farmers, but should be by all. For New Hampshire a standard variety is the Leaming dent corn, while in those portions of the state with too short a season for that variety to reach the proper stage, the Sanford flint corn can be advantageously used.

The sugar in the green fodder is practically all destroyed in the silo, and since it is most abundant in the corn plant in the early stages of ear development, it is an additional argument for postponing cutting until the grain is full size and the sugars have changed largely to starch.

The amount of seed per acre affects the yield of green fodder, and also its composition. A medium stand is essential for the best results in both quantity and quality.

The practice of using a half bushel of seed per acre is good. In a favorable season, with plenty of fertilizer, more seed could be profitably used, but the tendency to inferiority in quality, especially in decreasing the protein and increasing the sugar and fiber, render it, as a rule, inadvisable.*

It is a pleasure here to acknowledge the hearty coöperation in this work of Messrs. E. P. Stone, C. D. Howard, A. Given, R. H. Shaw, and H. A. Clark, who have in turn assisted me in these investigations.

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* Conn. Expt. Sta. Rept., 1889. Wis. Expt. Sta. Rept., 1897. Cornell Uni. Exp. Sta., Bull. 135.

PUBLICATIONS OF EXPERIMENT STATION

The following publications of the Station are available for distribution:

No. 2. Feeding Experiments.
No. 3. When to Cut Corn for Ensilage.
No. 4. The Science and Practice of Stock-Feeding.
No. 5. Fertilizers and Fertilizing Materials.
No. 6. Experiments with Fertilizers.
No. 7. Test of Dairy Apparatus.
No. 8. Feeding Experiments. Part 1. Principles of Feeding. Part 2. Corn Meal, Middlings, Shorts, and Cotton-Seed Compared.
No. 9. Effect of Food upon Milk.
No. 11. Pig Feeding. Part 1. Results of Feeding Skim Milk and Corn Meal versus Corn Meal and Middlings. Part 2. Digestion Experiment.
No. 12. Fertilizer Experiments.
No. 14. Ensilage in Dairy Farming.
No. 16. Effect of Food on Composition of Butter Fat.
No. 17. Stock Feeders' Guide.
No. 18. Effect of Food on Milk.
No. 19. Spraying Apples and Pears against Fungi.
No. 20. Effect of Food on Milk. Feeding with Fats.
No. 21. Farm-yard Manures and Artificial Fertilizers.
No. 22. Prevention of Potato Blight.
No. 23. Some Dangerous Fruit Insects.
No. 24. The Flow of Maple Sap.
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No. 69. Inspection of Fertilizers in 1899.
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No. 86. Growing Watermelons in the North, Classification of Watermelons.
No. 87. Thirteenth Annual Report. 1901.
No. 88. Inspection of Fertilizers, 1901, Analyses of Ashes, etc.
No. 89. The Squash Bug.
No. 90. Insect Record for 1901.
No. 91. Killing Woodchucks with Carbon Bisulphide.

Bulletin 93 October, 1902

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

THE
COLD STORAGE OF APPLES

PART I. Apples in Cold Storage.

By F. WM. RANE.

PART II. Influence of Cold Storage on the Decay of Apples. Effect of Wrapping Apples in Paper.

By HERBERT H. LAMSON.

PART III. Chemical Changes in Apples During Storage.

By FRED W. MORSE.

NEW HAMPSHIRE COLLEGE
OF
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PART I.

APPLES IN COLD STORAGE.

BY F. WM. RANE.

Apple growing is a prominent industry in New Hampshire and the question of the successful handling of the crop to get the largest possible returns is of general interest.

Experiments along the following general lines have been recently conducted at this station and the results are given in Part 1 of this bulletin:

I. The City Cold Storage for Storing Apples.
II. Results from Careful Handling, 1900–'01.
III. Range of Prices for Cold Storage Apples.
IV. Cold Air vs. Brine Systems of Artificial Refrigeration.
V. Where Does the Greatest Amount of Decay Take Place in a Barrel?
VI. Keeping Qualities of Cold Storage Apples When Taken Out.

In seasons with abundant crops, what is best to do with one's fruit,—sell at the market price, or arrange to hold it for future advance? This question appeals to every one who has apples for sale. To sell the fruit at picking time leaves little opportunity for competition, and results in low prices and limited responsibility. To keep the fruit for higher prices involves loss in the cost for storage buildings and the liability of shrinkage and decay; also extra expense in handling, danger from freezing in transportation, etc.

From the nature of the case, conditions vary and the problem is for the individual to settle. That cold storage of some form is profitable is readily recognized. We have had in recent years fruits of all kinds out of season and at prices within the reach of most people. The economic problem is not to secure a high price for a small quantity but an average price for a large quantity.

Not many years since we depended almost entirely upon the house cellar for tiding over a glutted market, and when there was a slump on the market much of the produce rotted in the hands of the producer. A certain few, however, even then solved the problem by proper handling, packing, ventilating their cellars, etc.; and they invariably received fair returns for so doing. New methods of storage have developed rapidly within a short time. At present every city of note has its commercial cold-storage plant and producers as well as commission men are offered equal opportunities for rental. Apples, for example, are stored usually for about the following rates: Ten cents per barrel per month, or for the season, from September until May first, 35 to 50 cents. The rate after that time is 10 cents per barrel per month or fractional part thereof.

The advantages of storage near markets are in being able to sell at short notice and in having one's fruit well cared for. This is worth consideration by all growers. Not all cold-storage houses are successful in giving good results. This may be the fault of the company in not keeping a regular temperature, etc., due to poorly constructed buildings or unskilled labor; but it may be due to lack of proper attention in picking, packing, etc., before the fruit reaches the plant. One must understand that cold storage will simply retard and not prevent entirely the spread of decay. Therefore, if the fruit is in prime condition on entering, it is likely to come out in proportionally as good condition. Cold storage never makes an ill-shaped apple shapely, an unsound fruit sound, a wormy apple perfect, or a pale, sickly, immature fruit bright colored. The apple cannot be expected to increase in size, or escape the consequences of the rough, careless treatment it perchance may have received before going in. It is for the interest of both parties concerned to get good results.

EXPERIMENT NO. I.

THE CITY COLD STORAGE FOR STORING APPLES.

The experiment as planned and conducted was to conform our conditions to those of the average New England fruit grower. We selected a number of barrels of apples from our general lot that we were selling in the open market in the fall of 1899, and on November 20 had them placed in the Quincy Market Cold Storage at Boston.

Beginning with February we arranged to have two barrels expressed to us each month. These were then closely examined, the number of apples counted, graded, and the percentage of rot calculated.

The first fruit arrived on February 5 and the last on July 11. This latter date is later than the customary time for keeping the fruit, but the test was continued simply for the data. Generally speaking the fruit is all sold by May 1.

The following table shows the results upon examination of the fruit each month as it was received. As already stated the amount is from two barrels. The fruit is divided into three grades to show their condition. The firsts are first-class, fine, perfect apples, the seconds are fruit that is usable, but injured in some way, while the thirds are of no value.

Date Put in.	Date taken out.	Number firsts.	Number seconds.	Number thirds.	Total number.
1899.	1900.				
Nov. 20.......	Feb. 5.......	837	75	145	1,057
Nov. 20.......	Mar. 5.......	811	92	189	1,092
Nov. 20.......	Apr. 3.......	882	89	137	1,108
Nov. 20.......	May 2.......	662	134	220	1,016
Nov. 20.......	June 5	374	283	355	1,012
Nov. 20.......	July 11......	314	298	494	1,106

It is evident from the above table that the apples under the conditions mentioned cannot safely be allowed to remain in cold storage after April as they rapidly decay after that date. The writer desires to emphasize the fact, however, that no extra precautions were taken with this fruit, and he believes the ordinary conditions in the case of apples that are purchased in the fall of the year for general use were represented in the experiment.

Experiment No. II.

RESULTS WITH MORE CAREFULLY PICKED APPLES FOR COLD STORAGE, 1900–'01.

In the fall of 1900 another experiment of shipping apples to cold storage was made. This experiment differed from experiment No. 1 in that the apples were picked on October 25 and 26 and assorted and shipped on the 27th, thus getting them into cold storage much earlier than before. The fruit was well colored and pains were taken to have it fairly graded and in good condition.

We did not examine this lot each month, but were content to allow them to remain until about April, at which time they were sold on their merit to commission men. The price apples were bringing at Durham when this shipment was made was $1.25.

On April 8 several commission dealers were informed that we had a number of barrels of apples in cold storage in Boston at the Quincy Market Cold Storage house. We also enclosed an order to them for two barrels each that they might examine the fruit and quote us such prices as would agree with the sale of the sample barrels.

One commission house after examining the apples sent the following report:

> "Dear Sir:—In response to your favor of the 8th inst., we have examined a portion of your lot of apples in cold storage, and think it will be as well, or better, for you, to allow us to sell them on commission, as to make price. They are good apples, but we judge were rather too ripe when stored, and showing quite a little decay; with some it may be necessary to repack, and we did not see any but what required 'plugging' before they are moved. Shall be glad to handle the lot for you."

Two barrels were allowed the above-named firm with the following returns: $7.00 less 25 cents carting and 8 per cent. commission, 56 cents, netting $6.19, or about $3.10 per barrel.

The lowest returns from any of the commission houses allowed the order for two barrels was $3.00 per barrel, with cartage 35 cents and commission 50 cents, netting $5.15, or $2.57 per barrel.

The returns for the two-barrel sales were received on April 13, 1901, in each case.

On April 23d an order for 10 barrels sent on commission brought the following prices: Two barrels at $3.50 and eight at $3.37½, amounting to $34.00. Charges, carting 50 cents and commission 8 per cent., $2.72. Net proceeds, $30.78, or $3.08 per barrel.

May 1, 1901. Another 10-barrel order on commission brought $3.00 each, or $30.00. Cartage and commission, $2.90. Net, $27.10, or $2.71 per barrel.

May 15, 1901. The last of the consignment to cold storage was turned over to a commission house. It consisted of 21 barrels. The returns from this lot were as follows: Three barrels at $3.25, 16 barrels at $3.00, and two barrels at $1.50; total, $60.75. Cartage, $1.05. Commission, 8 per cent., $4.86. Net proceeds, $54.84, or $2.61 per barrel.

The results of this experiment show that the fruit would probably have been better had it been picked earlier, say October 15th, rather than the 25th, for this season. The apples handled as these were, were in their best condition until, and not later than, April 15th. Under all conditions it paid well for that season to place the fruit in cold storage.

EXPERIMENT NO. III.

RANGE OF PRICES FOR COLD-STORAGE APPLES.

The range of prices for apples during the season of 1899 and 1900 was very good, as shown in the accompanying table. Apples that sold at from $1.25 to $2.00 in the fall brought $3.50 to $4.25 per barrel the first of April. The same table also contains the compiled data for the Baldwin apple, as published in the *American Agriculturist* for the New York city market during the three previous seasons.

It will be noted that in every instance the price has at least increased sufficiently to meet the storage rental, and on the average the practice has resulted in a good profit.

MONTH.	APPLE SEASONS.			
	1896–'97.	1897–'98.	1898–'99.	1899–1900.
Nov. 1	$1.00	$1.50 to $2.00	$2.50 to $2.75	$1.25 to $2.00
Dec. 1	.85 to 1.00	2.50 to 3.00	3.00 to 4.00	1.25 to 2.25
Jan. 1	1.00 to 1.12	2.00 to 3.50	3.00 to 3.50	2.00 to 2.75
Feb. 1	1.00 to 1.50	2.50 to 3.75	4.00 to 4.50	3.00 to 3.50
Mar. 1	1.25 to 1.50	2.50 to 3.50	2.50 to 4.50	2.50 to 3.50
Apr. 1	1.25 to 1.50	2.50 to 3.50	4.00 to 4.50	3.50 to 4.25
May 1	1.50 to 2.50	2.75 to 3.75	3.75 to 4.50	4.00 to 4.75

Further detailed prices for the apple crop sent to cold storage for the season of 1900–'01 are given under Experiment No. II.

Experiment No. IV.

THE COLD AIR *vs.* BRINE SYSTEMS OF ARTIFICIAL REFRIGERATION.

Six barrels of apples, all of the same variety, were marked and sent to each of two cold-storage systems in Boston on Nov. 20, 1899. On Feb. 5th a barrel from each system was taken out and the fruit counted, and data taken, as shown in the accompanying table. Each month thereafter until July a similar lot was received, and, like the first, the results from examination are tabulated in the same table.

From the table (see next page) it is seen that with the exception of the first month's comparison there were more spoiled fruits in the brine than in the cold air. As the experiment continued it is also apparent that the cold-air storage was preferable.

The following letter was received from Manager G. H. Stoddard, of the Quincy Market Cold Storage Company of Boston, Sept. 4, 1902:

> "For nearly all goods that are to be stored at a temperature above 32 degrees F. we prefer the air-circulation system to the brine system."

KIND OF STORAGE.	Date taken out.	Graded Fruits.			Total in barrel.
		No. firsts.	No. seconds.	No. spoiled.	
Cold Air	Feb. 5	414	42	75	531
Brine	" 5	423	33	70	526
Cold Air	Mar. 5	400	40	84	524
Brine	" 5	411	52	105	568
Cold Air	Apr. 3	417	44	74	535
Brine	" 3	465	45	63	573
Cold Air	May 2	362	64	100	526
Brine	" 2	300	70	120	490
Cold Air	June 5	225	146	145	516
Brine	" 5	149	137	210	496
Cold Air	July 11	194	167	238	599
Brine	" 11	120	131	256	507

EXPERIMENT NO. V.

WHERE DOES THE GREATEST AMOUNT OF DECAY TAKE PLACE IN THE BARREL?

It is generally noticeable that the apples that come next the head when the fruit is put in or the bottom of the barrel when taken out are those worst affected. This is accounted for from the fact that when heading, although the pressure is more or less evenly distributed throughout the barrel, those fruits nearest the head are bruised more than the others.

In order to get some data on this point, the fruit as it came from the barrels was separated into the following divisions: Upper half of barrel, lower half, and six inches next to the head, as put in. These divisions were again sorted into three grades, viz., perfectly sound, or number ones; slightly bruised, spotted or specked, or number twos; and those unsalable as badly bruised, decayed, etc., or thirds.

The following table contains the tabulations of the results throughout the season of 1899 and 1900:

DATE TAKEN OUT OF STORAGE.	Upper half of barrel.			Lower half of barrel.			Six inches next to head.			Total grades.			Total in two barrels.
	Ones.	Twos.	Spoiled.	Ones.	Twos.	Spoiled.	Ones.	Twos.	Spoiled.	Ones.	Twos.	Spoiled.	
1900.													
Feb. 5.........	384	20	30	350	32	52	112	14	58	846	66	140	1,062
Mar. 5.........	391	34	79	303	38	48	117	20	62	811	92	189	1,092
April 3....	387	34	40	365	37	42	130	18	55	882	89	137	1,108
May 2..........	313	57	70	265	53	74	88	24	76	662	134	220	1,016
June 5.........	182	138	120	131	82	88	61	63	147	374	283	355	1,012
July 11........	145	110	180	115	111	163	54	77	151	314	298	494	1,106

From this table it is shown that on the average at least 33⅓ per cent. of the loss from decay and bruises is found within the first 6 inches of the top of the barrel, and that the proportion between the lower and upper halves is as 504 is to 441.

This fact would again intimate that the pressure caused by heading slightly favored the decay in that portion of the barrel.

A custom with cold-storage men is to but slightly pack the fruit, not putting in so many when heading, and then to sort the fruit again when taking them out, thus lessening the number of bruises. A common practice, also, is to invert the head pieces when heading, and when the barrel is taken out to reverse the head. This helps to fill up the slack space. It is done more, perhaps, where one owns his own storage, although it can as readily be practised in the commercial cold storage house.

Experiment No. VI.

KEEPING QUALITIES OF COLD STORAGE APPLES WHEN TAKEN OUT.

It is generally thought that cold storage fruit keeps but a short time when taken out. An experiment for determining whether temperature has any marked influence on this question was planned as follows: Each month, when the apples were taken from the cold storage 150 were placed in three trays of 50 each. These trays were then placed under different temperatures. For this purpose two greenhouses of different temperatures —one high and the other medium—were used, also a cool cellar. The temperatures of the three are, during the winter season, approximately, 70, 55, and 40 degrees.

The apples did not touch one another, and were not covered. Each day the condition of the fruit was noted, and the accompanying table has been compiled from the data thus secured.

TEMPERATURE AND RESULTS IN WARM GREENHOUSE.

MONTH	Average temperature F.			No. days until first decayed.		No. decayed in 10 days.		No. days until one-half decayed.		No. days until all decayed.	
1900	a. m.	m.	p.m.	Spotted	Spoiled	Spotted	Spoiled	Spotted	Spoiled	Spotted	Spoiled
Feb. 5...	74	83	72	3	12	29	2	7	15	Incomplete.	
March 5.	76	84	68	3	10	37	5	6	12	14	22
April 3...	72	85	74	2	5	38	29	6	8	12	15
May 2....	......	...	.....	No record.		....	....	... .	....	....	....

TEMPERATURE AND RESULTS IN MEDIUM WARM GREENHOUSE.

MONTH	Average temperature F.			No. days until first decayed.		No. decayed in 10 days.		No. days until one-half decayed.		No. days until all decayed.	
1900	a. m.	m.	p.m.	Spotted	Spoiled	Spotted	Spoiled	Spotted	Spoiled	Spotted	Spoiled
Feb. 5...	57	67	55	4	13	18	0	10	26	48	58
March 5.	61	75	59	4	12	35	3	8	15	22	35
April 3...	63	74	59	3	10	25	6	10	18	40	49
May 2....	59	73	55	2	6	39	19	5	10	17	24

TEMPERATURE AND RESULTS IN COOL CELLAR.

MONTH	Average temperature F.			No. days until first decayed.		No. decayed in 10 days.		No. days until one-half decayed.		No. days until all decayed.	
1900	a. m.	m.	p.m.	Spotted	Spoiled	Spotted	Spoiled	Spotted	Spoiled	Spotted	Spoiled
Feb. 5...	43	45	43	3	25	5	0	16	43	66	87
March 5.	45	46	46	10	20	1	0	18	30	29	67
April 3...	49	50	52	7	16	7	0	15	23	50	61
May 2....	50	50	50	4	10	34	3	7	15	14	23

From a careful study of the comparisons of the above tables, it is readily seen that the length of time that apples keep when taken out of cold storage is in direct proportion to the height of the temperature they are subjected to.

Cold storage apples taken out during the spring months, if kept in a relatively cool place, will keep much longer than if allowed exposure to the ordinary temperatures.

Cold storage simply retards decay, and when the fruit is taken out at a time when conditions are so much more favorable for decay, the fruit decomposes faster than in the fall or winter when the temperature is low.

Comparing the average time it took for all of the fruit to become spotted under the three temperatures given, as shown in next to the last column in each table, they are about as follows: Warm temperature, 13 days; medium temperature, 32 days, and cellar temperature, 40 days.

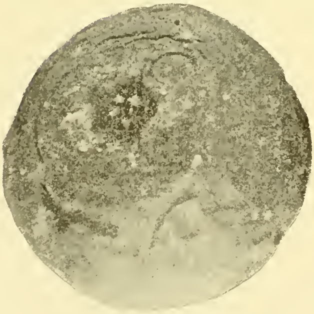

FIG. 1. Black Rot.

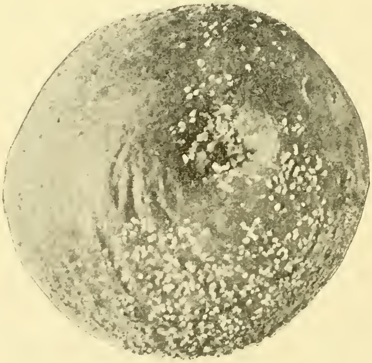

FIG. 2. Soft Rot.

PART II.

INFLUENCE OF COLD STORAGE ON THE DECAY OF APPLES. EFFECT OF WRAPPING APPLES IN PAPER.

BY HERBERT H. LAMSON.

Apples like all other products of life processes, if left to themselves, will undergo a series of changes to which the term decay is applied. In the vast majority of cases the agents of decay are living organisms belonging to the lower orders of the vegetable kingdom. The plants called bacteria are the most common cause of decay; but certain other somewhat more highly organized plants known as fungi also pay an important part in the breaking down of certain substances. The decay or rotting of apples is caused chiefly by the latter agents; bacteria do not find the acid reaction of apple pulp favorable to their developement.

Three species of fungi cause most of the rotting of apples; these are:

Black rot (*Sphaeropsis malorum*). In this the apple shows on the surface one or more brown spots which gradually spread until the whole apple is involved, the pulp remaining tolerably firm. Later the surface becomes darker or quite black in color and is seen to be studded with minute pimples or pustules. (FIG. 1.) These are the fruiting of the fungus which cause the rot, and contain the spores by which it is propagated. Microscopic examination of the pulp shows it to be permeated by the thread-like mycelium or vegatative part of the fungus.

Bitter rot (*Gleosporium fructigenum*). This rot is similar in naked eye appearance to the foregoing but produces somewhat darker spots and the pulp has a bitter taste.

Soft rot. In this form the color of the rotting area is lighter than in the preceding forms, being light or yellowish brown; the pulp may become very soft. The fruiting of this fungus occurs in white, rounded tufts upon the surface, the tufts taking on later a bluish-green color due to the matured spores. This form of rot is produced by one of the common mold fungi (*Pennicillium glaucum*), so abundant on various kinds of decaying matter.

The spores of the fungi causing these rots are produced in immense numbers, especially in the case of the last mentioned form, and as they are easily floated by slight currents of air, they are widely distributed, and, in all ordinary forms of handling, apples are more or less exposed to infection by them, but certain precautions will tend to limit the danger. Apples barreled in the orchard will be less likely to be infected than if they are previously stored, uncovered, in dusty barns or moldy cellars. The barrels themselves, especially flour barrels, are likely to be sources of infection unless they are thoroughly cleaned. The mold fungus producing the soft rot develops abundantly on such barrels if they are exposed to moisture. Heat and moisture favor the development of the rot-producing fungi, hence the advisability of storing in cool and dry places. In general it may be said that cold storage is the most practical method of controlling the rots which we at present have.

The results of two series of experiments are here reported. Series I was carried on in 1899–1900 and the results were published in the Twelfth Annual Report of the station; but it seems desirable to republish them here in connection with the results of Series II, which was conducted in 1900–1901.

Series I. November 18, 1899, twelve boxes (bushel market boxes) of Baldwin apples were shipped to the Quincy Market Cold Storage Company of Boston. The apples were No. 1s, selected from the mixed crop gathered at different dates during October. The boxes were filled after the apples had been thoroughly mixed to secure as great uniformity as possible; about two fifths of them were wrapped in manilla tissue paper.

The covers of the boxes were made of slats with spaces between so that there was ample chance for the circulation of air. The boxes were withdrawn from cold storage, one each month, until June, when they were withdrawn two per month until the twelve had been exhausted. On receipt of the boxes the apples were examined and the number of sound and rotten ones counted. The sound ones were stored in the station's cold storage room. A similar box for comparison had been kept here from November 18. The following table shows the results. Throughout the tables apples not perfectly sound are rated as rotten.

TABLE I.

BOX.	RETURNED.	TOTAL.		UNWRAPPED.		WRAPPED.	
		Sound per ct.	Rotten per ct.	Sound per ct.	Rotten per ct.	Sound per ct.	Rotten per ct.
1	Dec. 18, 1899	100	0	100	0	100	0
2	Jan. 17, 1900	*97	3	....	....	....	....
3	Feb. 14, "	*92	8	....	....	....	....
4	Mar. 19, "	77	23	83	17	69	31
5	April 23, "	82	18	84	16	78	22
Check kept in station cold storage.	April 20, "	61	39	54	46	74	26
6	May 23, "	67	33	63	37	70	30
7	June 19, "	62	38	61	39	64	36
8	" " "	48	52	50	50	46	54
9	July 17, "	54	46	52	48	58	42
10	" " "	55	45	46	54	57	43
11	Aug. 14, "	48	52	45	55	53	47
12	" " "	56	44	48	52	69	31

The temperature at which the apples were kept in the Boston cold storage was about 34° F. In the station cold storage

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*In case of Box No. 2, the wrapped apples were not opened when the box was first received. The percentage of sound ones is assumed to have been the same as in the unwrapped. The notes on No. 3 have been lost or mislaid. The percentages given are reckoned from the number in the box at the second examination, which were the sound ones when first received.

it was about 40° until April, when it rose to 45° during the first half of the month and to nearly 50° during the latter half.

No satisfactory explanation of the lack of uniformity in the increase of the percentage of rotten ones with length of time of storage can be offered.

The indications from the percentages in case of boxes 5, 6, 7, and check box, are that the conditions were more favorable to keeping in the Boston cold storage than in that of the station.

On June 1 only 5 per cent. of the check box apples were still sound, as against more than 50 per cent. in case of those still at Boston.

The following table shows the percentages of sound apples in wrapped and unwrapped lots, with difference:

TABLE II.

Box.	4	5	6	7	8	9	10	11	12	Check.
Wrapped	69	84	70	64	46	58	57	53	69	74
Unwrapped	83	78	63	61	50	52	46	45	48	54
In favor of wrapped	—14	6	7	3	—4	6	11	8	21	20

These figures, except in 4 and 8, are in favor of the wrapped ones. Later examinations of the first five boxes which were kept in the station cold storage after their return showed the same result.

April 20 a comparison of the first four boxes with the check indicated that they had not kept as well since their return as those stored at home; but May 29 a larger percentage of those that had been in the Boston storage were sound than in case of the check.

Series II. The Baldwins used were gathered mostly during the latter half of October. They were stored for a short time in the barn and were then packed in bushel market boxes as in Series I, special care being taken to secure uniformity in their contents. About half of the apples in each box were unwrapped and the other half wrapped. Four different forms of wrapping material were used, viz., heavy waxed manilla paper, thin waxed manilla, plain manilla tissue, and newspapers. November 1st, ten of the boxes were sent to the Quincy Market Cold Storage Company and four were placed in the station cold storage. The latter are designated as Checks 1, 2, 3, and 4.

TABLE III.

SERIES II.—1900-1901.

BOX.	RETURNED.	TOTAL.		UNWRAPPED.		WRAPPED.	
		Sound per ct.	Rotten per ct.	Sound per ct.	Rotten per ct.	Sound per ct.	Rotten per ct.
1	Jan. 2, 1901.	100	0	....	....	....	....
2	Jan. 2, 1901.	100	0	....	....	....	....
Check 1, station storage.	Jan. 2, 1901.	96	4	96	4	96	4
3	Feb. 7.	97	3	99	1	96	4
4	Mar. 5.	98	2	98	2	98	2
Check 2, station storage.	Mar. 15.	60	40	51	49	70	30
5	April 12.	97	3	99	1	95	5
7	June 7.	85	15	80	20	90	10
Check 3, station storage.	June 7.	16	84	13	87	21	79
Check 4, station storage.	June 14.	12	88	6	94	20	80
8	July 1.	82	18	72	28	90	10
9	Aug. 5.	48	52	34	66	76	24
10	Sept. 3.	55	45	34	66	76	24

In this series the temperature of the station cold storage ranged as follows: Nov. 1st to middle of December, 45 degrees; middle of December to middle of March, 40 degrees; middle of March to middle of April, 45 degrees; middle of April to middle of May, 45 to 50 degrees; middle of May to July 1st, 50 to 65 degrees. Quincy Market cold storage, 34 degrees.

An inspection of table 3 shows, Jan. 2d, a small percentage in favor of the lower temperature. The March and April boxes show over 35 per cent. more sound apples than check 2, examined March 15th, while in June, after the temperature in the station cold storage had risen, the difference is 69 per cent. in favor of the Boston stored apples.

An inspection of tables 1 and 3 shows that the apples in the Boston cold storage, except in case of the August box, kept better in the second series than in the first.

TABLE IV.

COMPARISON OF PERCENTAGES OF WRAPPED AND UNWRAPPED APPLES AT DATE OF FIRST EXAMINATION.

BOX.	1	2	Check 1.	3	4	Check 2.	5	7	Check 3.	Check 4	8	9	10
Wrapped........	100	100	96	96	98	70	95	90	21	20	90	76	76
Unwrapped......	100	100	96	99	98	51	99	80	13	6	72	34	34
In favor of wrapped.	...	...	....	-3	..	19	-4	10	8	14	18	42	42

TABLE V.

CONDITION OF APPLES IN JUNE AND JULY.

PERCENTAGES OF SOUND APPLES.	JUNE 14.			JULY 6.		
	Total sound.	Unwrapped sound.	Wrapped sound.	Total sound.	Unwrapped sound.	Wrapped sound.
Box 1..........................	22	16	28	4.9	3.8	6.2
" 2........................	28	21	34	3.1	0.0	6.2
" Check 1.	22	12	32	2.6	1.2	4.2
" 3............................	43	30	59	14.0	9.6	18.4
" 4...........................	30	15	47	8.5	2.9	14.5
" Check 2......................	18	10	25	2.5	0.0	5.4
" 5............................	45	27	60	18.0	5.2	31.0
" 7...........................	86	80	90	13.1	7.2	18.4
" 8...........................	....	......	....	81.6	72.0	90.0
" Check 3......................	16	13	21	....	....	.....
" Check 4......................	12	6	20	... .	....	.....

An examination of this table indicates that the apples kept as well after being withdrawn from the lower temperature as those which had not been subjected to it.

A comparison of tables 2, 4, and 5 shows that the wrapped apples kept decidedly better during the later months of storage than the unwrapped. A comparison of results shows but little difference in the effectiveness of the different wrapping materials; that clean newspaper is as good as the more expensive forms.

SUMMARY OF PART II.

1. The rotting of apples is due to the growth in them of certain fungi. Low temperatures are unfavorable to the development of the fungi. A temperature of 34 degrees is more effective than one of 40 to 45 degrees.

2. When it is desired to keep apples for an extreme length of time, *i. e.*, beyond the first of June, wrapping is of decided advantage.

PART III.

CHEMICAL CHANGES IN APPLES DURING STORAGE.

BY FRED W. MORSE.

The apple is a living organism when picked from the tree, and remains so after picking for days, weeks, and even months, under favorable conditions. This life is maintained, however, at the expense of its own constituents, and the apple is really undergoing a slow form of dissolution until decay attacks and destroys it, leaving only the fibrous portions of its structure and the seeds.

The process of dissolution is a continuous one, and is manifested by a respiratory action, during which water and carbon dioxide are exhaled as in the breathing of animals. At the same time there is a transformation and destruction of the constituents of the fruit, in order to produce these products of respiration.

The change in constituents of the apple during the earliest periods after picking has been called "after-ripening," and it has been fully studied by Kulisch* in Germany and Browne† in this country.

In brief, these changes have been shown to be mainly a transformation of starch into cane sugar in the first stage after picking, next the change of the cane sugar into invert sugar, and finally a slow decrease in the total quantity of sugars. At the same time, from the first, the acid in the fruit gradually grows less in amount, there being most in the unripe fruit.

The object of our investigations was to determine the effect of modern cold storage practice on these changes; whether they were retarded or not, and whether any change was induced by the low temperatures used.

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* Bied. Centr. Agriculturchem, 22, 625.

† Bull. 58, Penn. Dept. Agr.

The first season's work was devoted to a study of the changes in apples stored in the college cool cellar. The apples were gathered from one of the college orchards in the ordinary process of picking and handling. The first analyses were made soon after picking, and continued until April 20, 1899, at varying intervals. The analyses were all made by Mr. Arthur Given, now of the United States Department of Agriculture. Six Baldwin apples of varying sizes were taken for each analysis. One half of each was sliced in thin slices, and alternate slices taken for sugars and acids, while the remaining ones were used for the determination of water by drying. The sample for sugars was mashed to a pulp and allowed to stand in a flask with a measured volume of water. Corrections were made for the water in the fruit, on a basis of 15 per cent. dry matter. When sufficient time had elapsed for diffusion, aliquot portions of the solution were used for determining sugars and acids in accordance with the methods of the Association of Official Agricultural Chemists.

The results of this season's work are tabulated as follows:

COMPOSITION OF APPLES, 1898–'99.

DATE.	Average weight. Grams.	Water.	Dry matter.	Invert sugar.	Total sugar.	Acid.
Oct. 24, 1898	169.9	85.45	14.55	5.41	10.21	.60
" 31	157.4	85.41	14.59	6.10	11.13	.60
Nov. 7	146.3	85.34	14.66	5.59	11.44	.60
" 14	143.4	85.05	14.95	6.03	12.90	.57
" 21	161.4	85.23	14.77	5.81	11.18	.57
" 29	142.	85.02	14.98	7.20	11.52	.57
Dec. 5	129.5	85.20	14.80	6.68	11.51	.53
" 19	154.3	84.84	15.16	5.94	9.89	.48
" 27	174.6	85.42	14.58	6.53	10.39	.48
Jan. 2, 1899	142.6	85.56	14.44	6.87	11.02	.46
Mar. 8	152.1	84.66	15.34	7.92	12.20	.38
Apr. 20	127.4	86.19	13.81	7.96	10.91	.38

In 1899 a lot of Baldwin apples was sent to Boston for storage in the warehouse of the Quincy Market Cold Storage Company. The warehouse was one in which the temperature was maintained by air circulating over chilled pipes, which is not the usual practice; but as shown by Professor Rane's experiments, it is the best method for fruit.

The fruit was sent to Boston on November 21, after having been stored in a shed for about six weeks. The apples were packed in flat bushel boxes for storage, and a box was returned from the warehouse to the experiment station by express, at intervals of one month.

All the analytical work this season was done by Harry A. Clark. The samples were prepared this year by grating the apples with a common tin grater. As nearly as possible one half of each apple was taken. The pulp was thoroughly mixed and a sample weighed for diffusion, as in the preceding season.

The analyses this season were limited to the sugars, as their changes were most easily studied and appeared to show the rate of dissolution of the fruit. The apples this year were inferior to those of 1898 and were a little too ripe for the best practical results from cold storage, because the fall of 1899 was somewhat warmer than usual and had hastened the softening of them. The lot was also a mixed one from all parts of the college farm, and therefore it would be impossible to take samples which would be uniform in quality.

In selecting apples for analysis only sound hard fruit was chosen, as the object of our work was to determine the chemical changes which occurred with no influence of rot to interfere. The proportion of sound fruit to that which was decayed or withered is given in Dr. Lamson's report.

SUGAR IN APPLES, 1899-1900.

Date.	Dec. 19.	Jan. 18.	Feb. 15.	Mar. 20.	Apr. 27.
Invert Sugar.	3.45	5.50	4.64	5.36	5.66
Total Sugar...	5.12	6.59	6.89	6.55	8.17
	May 23.	June 20.*	June 20.*	July 18.	Aug. 14.
	3.92	4.27	4.22	4.22	3.63
	7.22	6.15	6.86	6.45	5.38

*Duplicate boxes.

In 1900 the utmost pains were taken to have apples which would be as uniform as possible. They were all picked October 17 from a vigorous Baldwin tree, which had been thoroughly sprayed throughout the season. Unblemished fruit, of as nearly uniform size and color as possible, was selected and put in paper bags, twelve apple in each bag. Two bags containing twenty-four apples were packed in a bushel box with other apples surrounding them, and shipped to the Quincy Market Cold Storage Company, where they were stored under the same conditions as in the preceding year. In all, six lots of apples were so prepared and sent to Boston on November 18, and one box at a time was returned by express at different dates, the last one being received in September, 1901. The preparation of the sample for analysis was carried out in the manner described for the previous year, and all the analyses were made by Mr. Clark. The first three lots returned were perfect; the fourth lot, received in July, contained two apples out of the twenty-four, that were slightly decayed, each having a spot about the size of a dime.

The lot returned in August contained one apple somewhat withered and one partly rotten; the last lot, returned the first week in September, had lost one half of its number, four being shriveled a little and eight partly rotten.

The sound ones only were used for analysis and had reached the stage at which all the cane sugar had become inverted. The keeping qualities of these lots of fruit emphasize the importance of careful handling.

VARIATIONS IN COMPOSITION OF APPLES, 1900-1901.

Date.	Nov. 13.	Jan. 2.	Mar. 5.	May 6.	July 1.	Aug. 5.	Sept. 3.
Invert sugar ...	3.60	4.19	4.36	3.90	5.85	5.24	5.62
Total sugar.....	5.89	7.30	6.32	4.10	6.95	6.76	5.93
Acid............	.50	.48	.44	.35	.29	.29	*
Lossin weight.		.33	2.34	3.60	4.71	5.90	7.04

From this data of different seasons, it is difficult to draw conclusions respecting the effect of cold storage on the chem-

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*Undetermined.

ical change in the fruit, because of the variations in composition with different years and the irregularities which occurred in the course of one season, even when the apples were all from one tree.

Cold storage evidently retards the rate of change in the after-ripening; but cannot prevent it. The inversion of the sugar was slower in the cold-storage warehouse than in the cool cellar, because by April the fruit in the latter had reached a stage in the development of sugars which was not reached in cold storage until August.

This late stage of ripening is marked by the familiar "mealy" appearance of the pulp and a lack of flavor, and although free from decay, the apple is practically worthless in competition with fresh fruit. In a cellar without ice, the temperature is bound to rise with the increase in warmth of the air outside, and at this point the rate of change in the apple increases rapidly.

The necessity for putting apples as quickly as possible into cold storage is shown by the following results obtained from windfalls and hand-picked fruit in the fall of 1898. Baldwin apples were picked from the tree at different dates and their composition compared with that of windfalls which had lain upon the ground for varying lengths of time. The windfalls show much higher percentages of both invert and total sugar than the hand-picked fruit fresh from the tree. At this stage there was considerable starch present in the fruit, which was shown by its settling on the bottom of the flasks in which the was pulp was placed for diffusing the sugar. The proportion was not determined, however.

The transformation of this starch into sugar would result in the increase of total sugar in the fruit at later stages, which is shown by comparing the total sugar at later dates in the first table, with the proportion given in this table.

COMPOSITION OF HAND-PICKED AND WINDFALL APPLES, 1898.

Date.	Tree.	Average weight.	Invert sugar.	Total sugar.	Acid.	Remarks.
Sept. 26....	No. 1......	161 "	4.16	7.76	1.03	Hand-picked.
" 29....	" 1......	68 "	6.56	10.40	.60	Windfalls after being on ground 2 to 4 wks.
" 1.....	" 2......	70 "	6.37	9.63	.70	Windfalls after being on ground 2 to 4 wks.
" 4.....	" 1......	135 "	5.21	9.55	.93	Windfalls, less than week on ground.
" 10.....	" 1......	176 "	4.53	8.32	.66	Hand-picked.
" 12.....	" 3......	164 "	4.93	8.23	.83	Hand-picked.
" 14.....	" 3......	143 "	5.94	11.22	.66	Windfalls about one week on ground.
" 17.....	" 1......	157 "	5.46	9.55	.70	Hand-picked.
" 17.....	" 4......	191 "	4.93	9.24	.84	Hand-picked.
" 17.....	" 5......	179 "	4.73	9.28	.79	Hand-picked.

At temperatures of 60 degrees to 80 degrees Fahr. apples change rapidly, and so far as this change is due to the formation of invert sugar, the temperature is the most important factor in its control. Cane sugar is changed to invert sugar by a ferment or enzyme called invertase,* which exists in the cells of many species of plants, and especially the yeasts. It has been found in several fruits and probably exists in the apple. By the transformation of cane sugar to invert sugar, a sugar is formed which is capable of further decomposition into simpler compounds, the best known change being the one into alcohol and carbon dioxide, occurring in fruit juices, of which cider and wine are made.

O'Sullivan† has shown that the enzyme invertase is active but slow at 32 degrees Fahr., while at 70 degrees its effect on the inversion of sugar is quadrupled, in fact, its activity doubles for every increase of 18 degrees Fahr.

It is evident, therefore, that the lowest possible temperature at which apples may be kept without freezing, is necessary to most effectively retard changes in the fruit, which are entirely independent of the attacks of fungi ; but are the results of activity within the cells of the apple itself.

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* "Fermentation," Reynolds Green, Chap. 8.

† Jour. Chem. Soc., 57, 834.

SUMMARY OF RESULTS.

Apples placed in cold storage, four to six weeks after picking, kept in good condition until the following April, after which they decayed rapidly.

Apples placed in cold storage in October, 1900, and sold in April, 1901, were more profitable than fruit sold at harvest time.

When apples were kept in cold storage until June, there was more loss in the brine system of cooling than in the air-circulation system.

Apples decayed fastest at the end of the barrel which was headed after packing. This was evidently due to the bruises produced by the operation of heading.

Cold storage does not injure the fruit nor lessen its keeping qualities after removal from the warehouse.

The lower the temperature, the more effectively is decay hindered. Cold storage hinders, but does not stop decay.

Wrapping apples in papers was advantageous when they were kept until June, or later. The kind of paper made little difference, provided it was clean.

Chemical changes take place within the apple, which are independent of decay and result in the over-ripe condition, recognized by "mealy" pulp and lack of flavor.

Low temperatures hinder the chemical changes, while high temperatures hasten them.

Apples intended for cold storage should be carefully handled and placed in the storehouse as soon as possible after picking.

Bulletin 94 **October, 1902**

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

REMEDIES FOR FLEAS

BY ALBERT F. CONRADI

One of the most annoying pests of our dwelling-houses is the dog flea (*Pulex serraticeps*). These are small reddish brown creatures with a hard, smooth body covering; the sides are flattened, which enables the insects to make their way through the hair of the host with great ease. Along the lower side of the head and anterior portion of the body are two rows of spines, from seven to nine in each row; these spines project backward in such a manner as to push forward the body at every motion and are of special service in aiding the little tormentors to escape when captured. The legs are fitted for walking and jumping. They crawl through between the hairs with great rapidity and can leap great distances with astonishing quickness.

It is in this adult state that the fleas are best known and most troublesome. Their larvæ and pupæ are minute organisms hidden among the hair, or in bedding and old clothing, where they gnaw the rubbish about them.

Though the ideal breeding place of the flea is among the hairs of our household pets, it is by no means confined to them. One of these little intruders will inflict so many bites on a single human being as to impress upon him that he is infested by the pest; the capturing and destroying of a single specimen will often remedy the evil. As the mouth parts are formed for piercing and sucking, the bite is especially irritating.

The fleas make their appearance with different degrees of severity during the course of years, depending upon the conditions in the dwelling-houses and the number of fur-bearing pets. The writer at one time lived in a small village, one section of which was greatly infested with fleas. The following year some of these badly infested houses were free from fleas, though no measures for their extermination had been adopted. Upon inquiry it was found that the cats and dogs had been destroyed some time before spring house cleaning.

REMEDIAL MEASURES

Various remedies for fleas have been devised. The use of rugs for carpets is to be recommended as this prevents the breeding to some extent. The rooms should be kept free from rubbish, as well as thoroughly clean, and well aired.

Persian Insect Powder.—Persian insect powder dusted among the hairs of the animal or in the room serves as a preventive, but on the whole has been very unsatisfactory wherever it was used.

Handpicking.—Handpicking is out of the question where the insects have established themselves in great numbers. However, as has already been stated, a single intruder may be the cause of much alarm and when removed the evil is remedied.

Creolin Washes.—The most satisfactory remedy we have found is in the use of creolin. This substance in diluted form has been used for various purposes for many years, such as disinfectants, deodorants, insecticides, etc. It has not been, however, generally recommended for fleas.

The time to combat an insect pest is when it is in its infancy. The fleas make their appearance on the fur-bearing animals about our dwellings and their presence is easily recognized when the animal begins to scratch and bite its fur. As it is among these hairs they begin their breeding, the treatment should begin here.

The animal should be thoroughly washed with a mixture of creolin and water. This will destroy the adults as well as the larvæ and thus prevent further breeding. For dogs a 3 per cent. solution should be used; for cats a 2 per cent. solution, as the fur is more sensitive and the hair finer and will hold the solution longer.

How to make the Solution.—Commercial creolin may be bought at any drug store as a blackish brown liquid, costing about 25 cents a pint. When this is mixed with water it forms a milky white solution.

The proper mixture can be made by means of a graduated glass cylinder. Where this is not available a 3 per cent. mixture can be made by adding 4 teaspoonfuls to a quart of water or 4 tablespoonfuls to a gallon of water. A 2 per cent. solution may be made by adding 2 teaspoonfuls to a quart of water or 2 tablespoonfuls to a gallon. Shake well and the mixture is ready for use.

How to Wash.—This operation may be performed by preparing a small quantity of the liquid and applying it to the animal with the hands or brush, or a quantity sufficient to completely submerge the patient. Submerging is the easiest way and should continue five minutes so that the fur is thoroughly saturated. After the removal of the animal no more attention is required than if the animal were submerged in clear water. This wash will kill all the fleas on the animal.

Creolin is not poisonous but the solutions need not be used stronger than here recommended. It should never be used pure internally.

A thorough wash not only destroys the fleas but other vermin, that may be infesting the skin, as well. It cleans the fur, making it soft and smooth, and heals up the small irritations in the skin that occur on flea-infested animals.

The writer has used creolin in many cases as a deodorizer. Dogs and cats returning from filthy localities, carrying in their fur putrid odors, when washed in one or two per cent. creolin, are rendered inoffensive. It was found very effective when applied to a dog that had killed a skunk. The odor of creolin is a very clean one and is disagreeable to few people.

Unless the fleas are removed from houses the wash must be repeated occasionally as the intruders will soon find a breeding place in the soft fur. The measures outlined below are very effective to rid our dwelling-houses of this pest.

Substitute Rugs for Carpets.—The situations in which household insect pests are most likely to breed are under carpets, rugs, and mats; also under various things piled on the floor, such as books, boxes, and papers: consequently it is desirable that rugs and mats should be substituted for carpets, because the former can easily be taken outside and aired; there they should be beaten and shaken to remove the eggs and larvæ of the fleas as well as the adult insects.

Floors Should be Treated.—All unnecessary material should be removed from the floor. If the floor contains cracks and crevices the immature stages of the intruders are sure to be there; such floors should be scrubbed with a five per cent. solution of creolin.

Treatment of the Resting Places.—Where fur-bearing pets are kept in dwelling-houses their bedding should be thoroughly saturated occasionally with a five per cent. solution of creolin. When a rug or mat or some old piece of clothing is used, this may be most easily accomplished by submerging it in the solution prepared for that purpose.

Hydrocyanic Acid Gas.—Should the infestation be such a desperate one that all these measures fail, as a last resort the house may be fumigated with hydrocyanic acid gas. This, however, is so dangerous a process, on account of the deadly qualities of this gas, that no attempt will here be made to give directions for its use. A complete treatise upon it will be found in Johnson's *Fumigation Methods*, and general printed directions may be obtained on application to the U. S. Department of Agriculture, Washington.

Bulletin 95 **November, 1902**

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

HOW TO GROW

A FOREST FROM SEED

Oyster River flowing through New Hampshire College Woods.

BY F. WM. RANE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

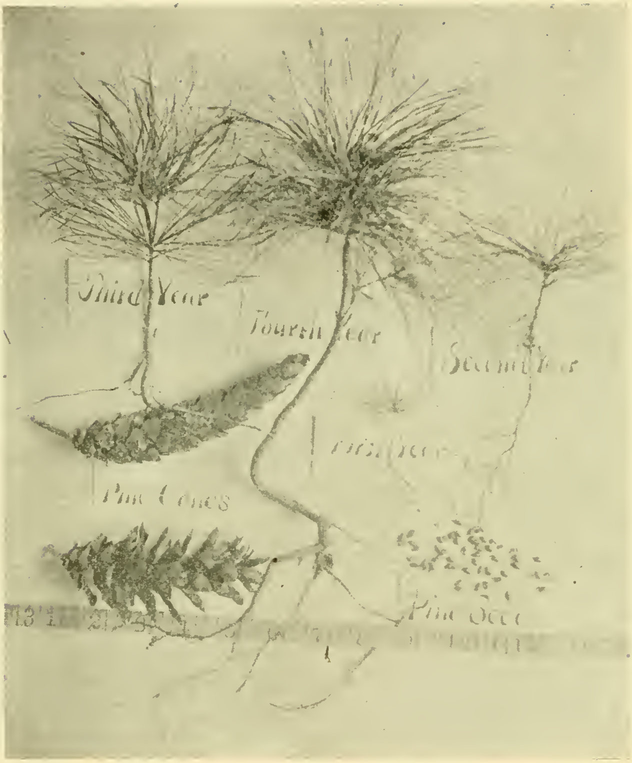

FIG. 2. *The young pine tree at the beginning.*

(1) The pine cone closed as it comes from the tree containing the seed.

(2) The open dried cone from which the seed has been taken.

(3) The pine seed after the wings are rubbed off as it is purchased on the market.

(4) The seedlings as they appear during the first four years of their existence.

HOW TO GROW A FOREST FROM SEED

BY F. WM. RANE,

Professor of Horticulture and Forestry, New Hampshire College.

The question of how to utilize the unproductive and waste lands throughout New England should be solved in one of two ways. They should receive such care and attention that they could be classified as crop or farm lands adapted to practical and successful agriculture, or they should be set aside for wood or forest growth.

The forest should be considered as an actual field crop, and a knowledge of its culture and handling is highly essential. When the wood is harvested the crop should be renewed immediately, so that the land may be kept in constant use.

I. WHERE AND HOW TO OBTAIN SEED?

A large number of inquiries are coming to the writer asking for information, especially concerning white pine seeds. The following is given with the belief that others may make use of the information:

1. Collect your own seed.

The simplest, best, and most interesting method is to collect your own seed. Find out when the seeds are ripe and the best time and method of getting them; then give them the proper care, and plant when conditions are favorable.

To illustrate, let us take the white pine. This tree ripens its seed in this climate, usually, early in September. One can readily tell whether there is a crop of seeds from the number of cones that have grown on the tree during the year. These pine cones contain the seeds of the pine. They should be collected before the cones have so far advanced as to open and let the seeds within drop out. The pine seeds have a small wing extending from each seed, and if the cones are allowed to remain on the tree until the cone opens, these wings assist them very much in their distribution. On a windy day the seeds are carried a great distance.

To collect pine seeds the best and easiest way is to find out where lumbermen are at work and as they fell the trees collect the cones. The cones can also be picked by climbing the trees and by the use of ladders, etc. After gathering, the cones are placed in the sun or some warm place where they will dry and open, when the seeds are easily extracted. Be particular to keep the cones from getting wet or moist or they will close up. Various devices can be arranged for drying

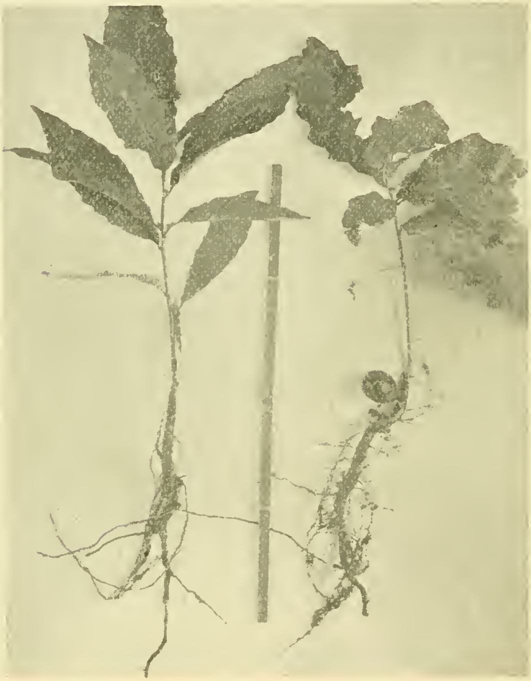

FIG. 3. Seedling Chestnut and Red Oak. Seeds were planted in November, 1901, and this photograph was taken in October, 1902. The first year's growth.

them and extracting the seed. A warm room with a stove in it, a greenhouse, evaporating house, large oven if not allowed to get too hot, etc., will answer, much depending upon the amount to be handled. In Germany there are buildings constructed for the purpose, where slat trays containing the cones are placed one above the other, and as the seeds drop out when stirred, they fall through and are collected at the bottom.

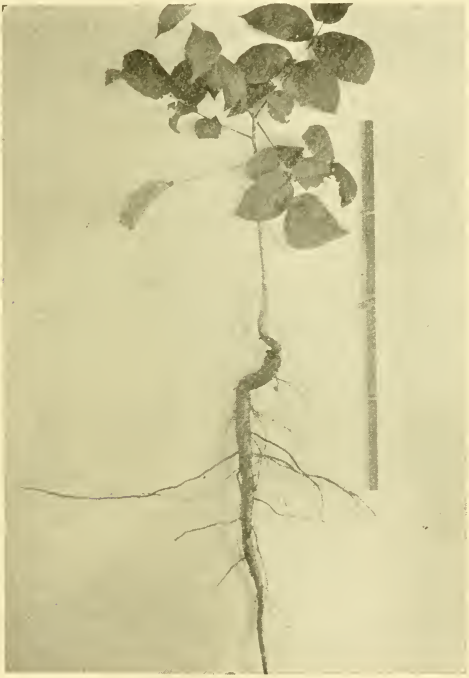

FIG. 4. Seedling Black Walnut. Seeds (nuts) were planted in November, 1901, and this photograph was taken the following October.

One of our ingenious men in this state got permission from a large lumberman in his section to cut such trees as he wanted. The trees were to be cut anyway the following winter, and it was an advantage to the lumberman to get them cut for nothing. This man, Mr. James H. Bliss, of Winchester, N. H., wrote me as follows: "I and two men with me spent nearly two days cutting about fifty trees and picking the cones from them. We gathered two wagon loads, some fifty bushels, before the cones were opened very much; after drying there were probably one hundred bushels of cones.

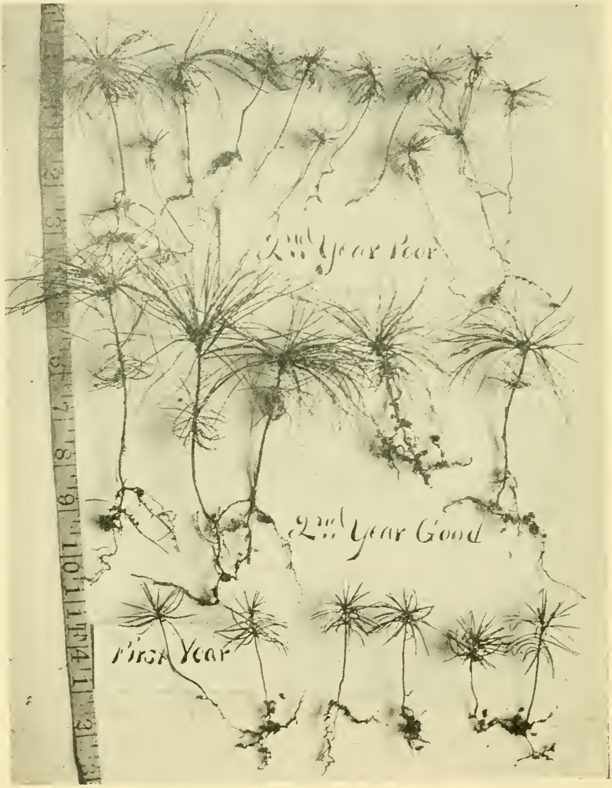

FIG. 5. One year old and two year old White Pine seedlings taken from the woods.

The second year poor seedlings have made very little growth the second year, due to insufficient light. *The second year good* seedlings were secured from a partially open space in the same forest.

These I spread in my barn and carriage house, leaving doors and windows open. I also made a floor of boards out of doors, covering it with a large cloth which I use to cover my top carriage with. This platform I found was the best place to dry the cones as they got all the hot sun as well as wind. Fortunately we had a hot, dry spell of weather and but little rain. If the cones get wet they close up. Every day I stirred them up once or several times with a rake. When well opened I thrashed them and carefully raked off the cones and gathered up the seed. I obtained about five bushels of seed. I did not winnow it or take pains to get it very clear from needles, etc. It took me about two weeks to get the seed from the cones."

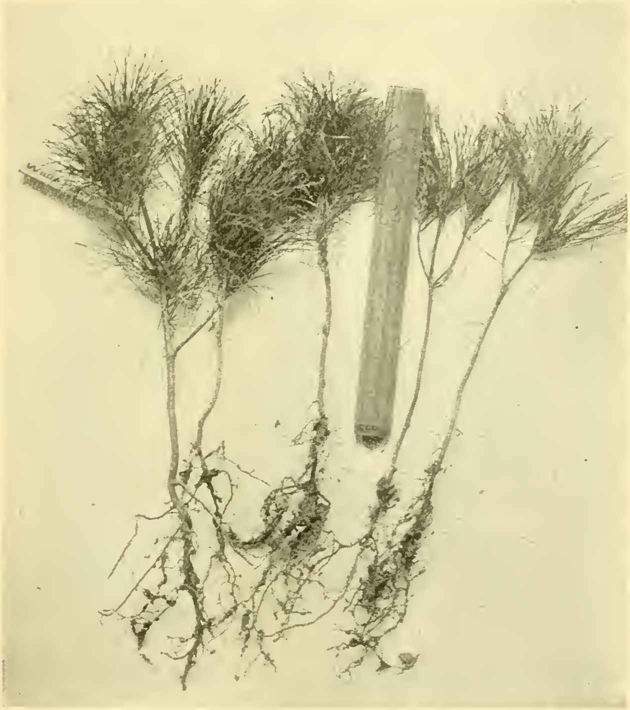

FIG. 6. A sample of four to six inch White Pine seedlings from a Western nursery. Price $3.00 per thousand when purchased in quantities; $4.00 for single thousands.

I quote the above because it contains in a precise and practical way just what people want to know.

It is claimed that the pine has a full crop only about once in seven years, but the crop varies with the seasons and more or less seed can be had at much shorter intervals. It often happens that a few miles away, or in another section of the same state, seed can be gathered, while in the immediate neighborhood there are no cones. In this way seeds can generally be found somewhere nearly every season.

2. *Purchasing seed from dealers.*

There are only a few firms that deal in tree seeds in this country. Thomas Meehan & Sons, Deshertown, Pa., and D. Hill, Dundee, Ill., are two responsible firms. If only a small quantity is wanted send for their price-list. If purchasing in quantities write for quotations on the amount desired. White pine seed usually costs two dollars a pound, unless a quantity of ten pounds or more is desired, when it may be procured at about one dollar and a half a pound. There are about twenty thousand pine seeds in a pound. It is a good idea to test their germinating qualities before planting, in order to know about the quantity of seed to use. It is claimed pine seed will keep for at least five years with fair percentage of germination if well cared for.

II. CULTURE.

(*a*) *Soil and location.*

While, as observations well show, white pine will adapt itself to most soils where it is indigenous (native) it will be found that certain soils and locations will give much quicker results than others. Favorable conditions are, in general, a suitable soil, moderately warm and moist but not wet, and so located as not to dry out too quickly and having natural or artificial protection from the sun and wind at least part of the day during the earlier stages of the plant's development. As with other farm crops, the better the seedbed the greater the chances for success. Some trees, like the pines and gray birches, will grow on a very poor soil like pure sand, if they are assisted in getting a foothold, while other trees, like the oak and walnut, demand a more substantial subsistence. Most soils, therefore, may be adapted to forest growths by a proper study of the conditions and adaptations, poorer soils needing more attention than good ones.

(*b*) *Planting*.

Just how to handle the seed in planting will depend very much upon whether one has collected his own seed at a minimum cost or purchased it; also, whether the land to be handled is cleared, scrub, or waste lands. If the seed has been collected in quantities and at little expense, one can afford, perhaps, to sow it broadcast and run the risk of a portion of it germinating and growing. If the land cannot be cultivated, and all that one can do is to simply sow the seed, the quantity of seed should be the maximum amount.

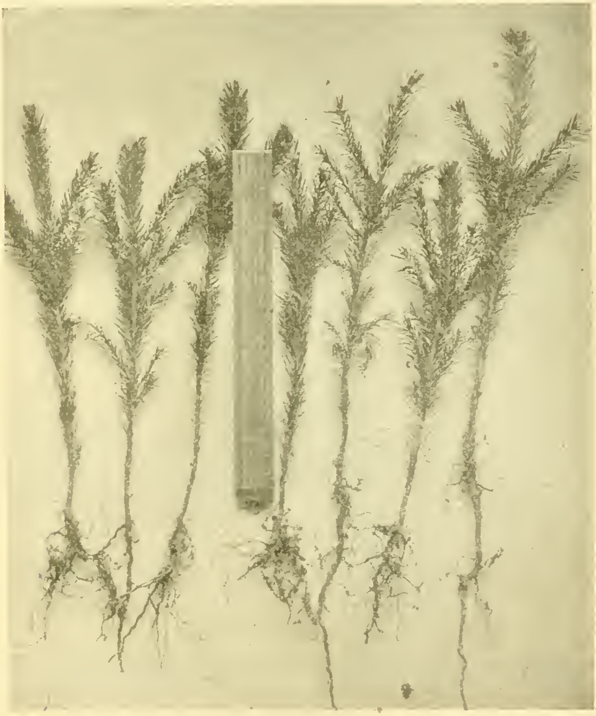

FIG. 7. A sample of six to eight inch spruce seedlings from a Western nursery. Price $4.00 per thousand in large lots; in smaller quantities $5.00 to $10.00 per thousand.

This is nature's method of growing pine trees, and we find that wherever the seeds find a congenial condition they do well. A much surer method, however, and one requiring more labor and painstaking, is to prepare the soil for the seed. This may be very crudely done, or well done, as occasion demands. The surest method, and often the quickest and altogether the most satisfactory, is to plant the seed in a well prepared seed bed where they can be given the best of care.

The seed bed should preferably be ground that has been used for some cultivated crop the previous season, so that it will be free from witch grass and weeds. Fall plowing is also recommended, as the ground will thus dry out and be ready for planting earlier the following spring. The seed may be sown in the fall provided everything is in readiness, but taking into consideration that more or less of them may be destroyed through insects, birds, squirrels, freezing and thawing, etc., and that equally good results are obtained by early spring planting, the latter season would seem the preferable one.

The seeds may be planted in drills, or sowed broadcast. For most of the hard woods the drill row is preferred, but nurserymen largely practice sowing the pine seed broadcast where the seedlings stand from two to four years before transplanting.

For acorns, walnuts, and the hard shelled seeds, planting in the fall of the year is commonly practised. The action of the frost and weathering conditions favor their opening and hence assist germination. If they are not planted in the fall the very hard shelled ones are layered in sand, and then subjected to freezing and thawing during the winter, and in the spring sifted out and planted as already recommended. Layering is to take a box, or boxes, of convenient size, putting in a layer of sand and then a layer of the nuts alternately, using only enough sand to assist in retaining moisture and keeping the layer of nuts apart. The whole should be well wet down when putting in. The advantages from layering in this way are that the ground can be well prepared in spring to receive the seed, and that one may get a good idea as to the percentage of seed that is good. Where, as in the case of the peach pit, the shell does not open sufficiently, they may be cracked by hand and simply the meat or kernel planted. If the conditions have been favorable and the seed good, however, they will have swollen or cracked sufficiently so that the young embryo will be able to make its appearance as soon as the warm days of spring impart congenial conditions to it.

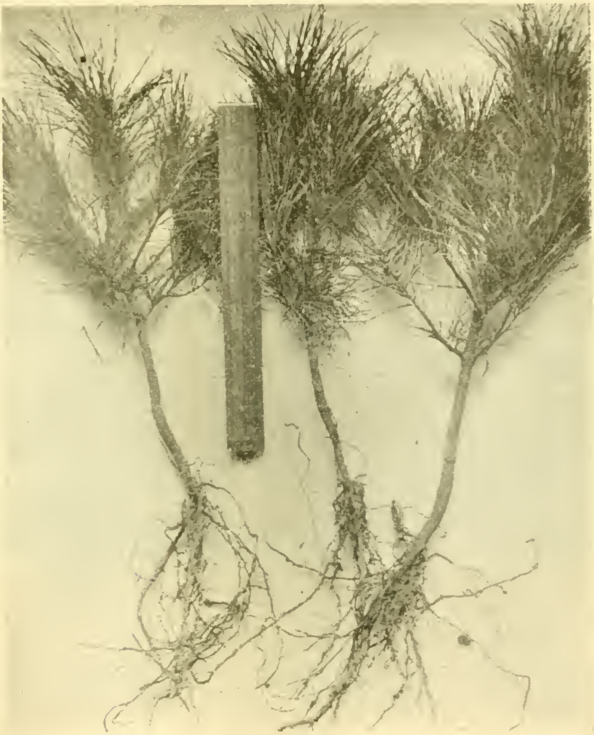

FIG 8. A sample of ten to twelve inch White Pine transplants, from a Western nursery. Price $25.00 a thousand, or $3.00 a hundred.

(*c*) *Depth to plant.*

The depth at which various seeds should be planted varies with the size of the seed and nature of the soil. The seed should not be sown too deeply, a depth not to exceed twice their own diameter being recommended. In a clay soil they are often thrown out by the frost, and hence should be given a little deeper planting. Strong growing seed like the black walnut, the writer has observed germinating and growing from a depth of six and eight inches, but they lose much time in getting to the sunlight, and many become discouraged in making their way through the soil. The illustration of the oak seedling shows that the seed is very near the surface. The idea is to get the seed into the ground only so far as is necessary for it to get sufficient moisture and soil to establish itself. It is a great mistake to plant too deeply. Do not delay planting early in spring. The seeds need the moist early spring conditions.

(*d*) *Growth of seedling.*

The growth of the white pine seedling is only from one to two inches the first year, while that of the oak, chestnut, walnut, etc., is nearer a foot. Where seedlings do not receive any culture, as in nature, their growth is much slower and hence nursery grown seedlings are usually larger. The white pine is too small and delicate to transplant the first season. When two years of age they range in size from three to five inches and have a well-developed root system of fibrous roots and will stand transplanting. At the age of three years they average between six and ten inches and should not be allowed to grow longer without transplanting, either to the permanent grounds or to the nursery row. Where some seedlings are allowed to stand four years, the larger and better plants are taken out during the second and third seasons, thus giving them room to develop. Where sown thickly the tendency is to grow up spindling, and this should not be allowed to go too far.

(*e*) *Transplants.*

This is a term applied to seedlings after they have been transplanted at least once. By transplanting them and giving them more room they develop into a more sturdy growth and are thought to withstand again transplanting to their permanent quarters better than seedlings. Not only a better top but a more symmetrical root system is found on the transplant.

The more a small tree is successfully transplanted the greater the tendency it has to form a ball of fibrous roots called the root ball about its base.

(*f*) *Distance apart for trees to stand.*

There is much discussion at present as to what is the proper distance to set young seedlings or transplants. Naturally, the greater the number the greater the expense. The object in setting them closely at first is to induce the plants to grow upright, and also to kill the lower limbs, thus making the better grade of lumber. While this is highly desirable it can be carried too far. Even if the plants come up thickly from seed in nature some must die to enable others to survive. The struggle for existence is continually going on. Nature's methods, however, are slow, and we assist much when we thin at the proper time, thus giving the remainder more food and an opportunity to develop. Some claim that pines should be set at least as close as 4x4 feet while others place them as far apart as 10x10 feet. We find advocates for both in New Hampshire, and their results will be watched with much interest. Taking into consideration that the former will take 2,722 trees to set an acre and the latter only 435, one can readily see the first expense will be vastly different.

FIG. 9. Nature's slow method of reclaiming forest lands.

(*g*) *Care of the Plantation.*

After the land is stocked with trees the work is not wholly done. It is necessary that fires and animals be kept out. A fire if allowed to run over the plantation will destroy one's work in a very short time, and animals, while they may not seem to be very destructive, nevertheless destroy far more vegetation from trampling alone than most people imagine. The practice of allowing animals to run in the woodlots where there is practically no food and in which they can be of no possible benefit, but a hindrance, should be condemned. There are many so-called pastures that would be valuable forest properties to-day had animals been kept out of them. Lands that are adapted for agriculture should be retained and used for that purpose, but when they cease to be of profit they should be turned over to forests, and they will increase in value in proportion to the care given them.

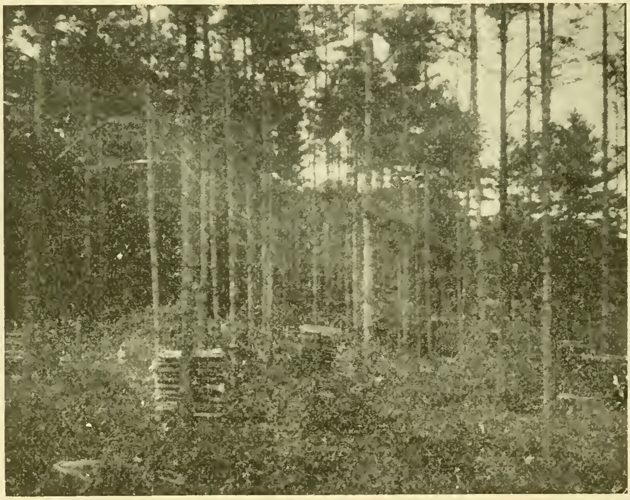

FIG. 10. Making improvement cuttings. By harvesting a part of the crop every six to ten years those trees that remain grow rapidly in value. Be careful to do the work right.

(*h*) *Harvesting the Crop.*

When one has finally succeeded in getting a good stand of timber, he should acquaint himself with economic methods of management. To harvest the crop in order to get the largest financial returns, and to have another crop immediately started, thus securing from the land its largest possible production,—these are the methods of true forest management.

If the trees will bring more money for partially matured growth than they would if not cut until mature, the earlier period is to be recommended. The land thus cut off could meanwhile be growing a second crop. Where box boards bring a high price if pine, or where hard woods are worth more for fuel for brick yards, fishnet poles near the sea, etc., than they could possibly bring for future lumber plus taxes and compound interest, one is justified in harvesting early. Much depends upon one's location and prevailing conditions. For further discussion, the reader is referred to Bulletin No. 26, Division of Forestry, U. S. Department of Agriculture, Washington, D.C. This treatise may be had upon request, and the author, Prof. H. S. Graves, treats the subject, "Practical Forestry in the Adirondacks," in a plain and practical manner.

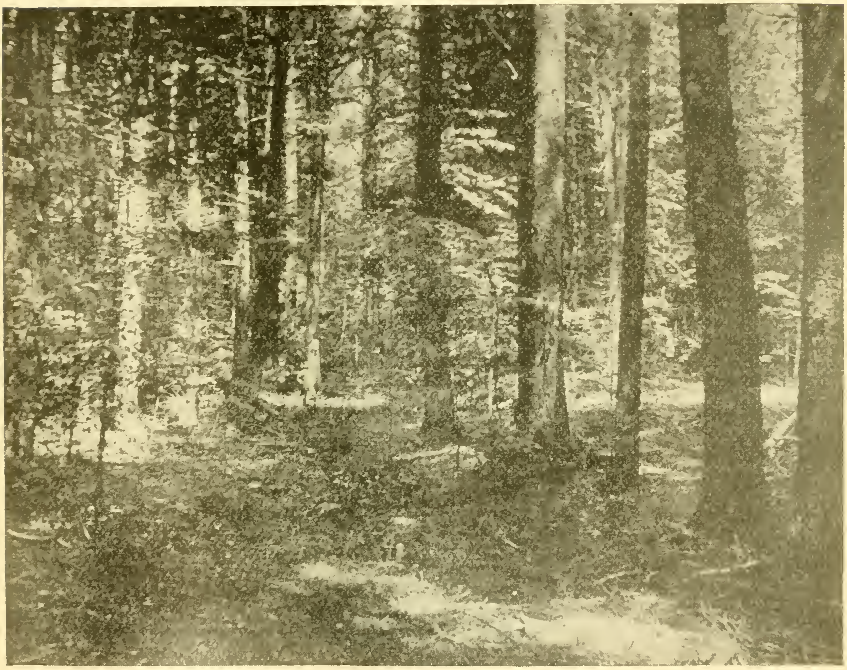

FIG. 11. A view of mature growth of pine and hemlock in the New Hampshire College woods.

Bulletin 96 November, 1902

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION.

FOURTEENTH ANNUAL REPORT

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM.

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS.

AGRICULTURAL EXPERIMENT STATION.

DURHAM, N. H.

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*Resigned August 31, 1902. †Elected September 1, 1902.

FOURTEENTH ANNUAL REPORT.

ANNUAL STATEMENT

Of the Hatch Fund of the New Hampshire College of Agriculture and the Mechanic Arts, for the year ending June 30, 1901.

RECEIPTS.

Cash received from United States treasurer	$15,000.00

EXPENDITURES.

Cash paid for salaries	$9,010.39
labor	1,825.13
publications	1,329.35
postage and stationery	95.21
freight and express	92.00
heat, light, and water	583.37
chemical supplies	102.49
seeds, plants, and sundry supplies	378.59
fertilizers	186.90
feeding stuffs	7.00
library	253.86
tools, implements, and machinery	153.93
furniture and fixtures	351.65
scientific apparatus	286.73
traveling expenses	293.79
contingent expenses	20.60
building and repairs	29.01
	$15.000.00

SUPPLEMENTARY STATEMENT.

RECEIPTS.

Balance on hand	
Cash received for analysis of fertilizers, water, etc.	$592.50
	$592.50

EXPENDITURES.

Heat, light, water, and power	$21.99
Contingent expenses (fire insurance premiums)	318.30
Chemical supplies	2.30
Labor	249.91
	$592.50

REPORT OF VICE-DIRECTOR.

To Charles S. Murkland, President:

By the resignation of the director, Prof. William D. Gibbs, August 31, it has become my duty to prepare the annual report of this station, and I, therefore, have the honor to submit the following:

The Agricultural Experiment Station has been seriously handicapped during the year now closed, by the repeated changes in its Agricultural Department, which prevents continuity of work and completion of experiments, and results in a lack of material for bulletins in subjects of paramount importance to the farmers of the state.

The other departments are each doing their full share of work in research and practice and the bulletins of the station are in continuous demand both without and within the state. But the men in those departments cannot well take up the notes gathered in the Agricultural Department, collate them and write out the results in a bulletin, and at the same time further the work in their own proper lines.

Prof. William D. Gibbs was elected director and agriculturist and entered upon his duties January 1, 1902; but resigned September 1 to accept a larger field in Texas.

Prof. Harry Hayward, M. S., was appointed agriculturist, September 1, 1902.

Mr. Herbert M. Tucker was appointed superintendent of the farm, April 1, 1902.

Mr. Lucian A. Hill, A. B., assistant chemist, March 15, 1902.

Mr. Arthur L. Sullivan, B. S., assistant chemist, September 15, 1902.

Nine bulletins in the regular series have been published during the year as follows:

No. 88. Inspection of Fertilizers, 1901, Analyses of Ashes. By Fred W. Morse.

No. 89. The Squash Bug. By Clarence M. Weed.

No. 90. Insect Record for 1901. By Clarence M. Weed.

No. 91. Killing Woodchucks with Carbon Bisulphide. By Clarence M. Weed.

No. 92. Silage Studies. By Fred W. Morse.

No. 93. Cold Storage of Apples. By F. William Rane, Herbert H. Lamson, and Fred W. Morse.

No. 94. Remedies for Fleas. By Albert F. Conradi.

No. 95. How to grow a Forest from Seed. By F. William Rane.

No. 96. Fourteenth Annual Report.

Two bulletins have been added to the Technical Series, namely:

No. 4. The Acetylene Light in the Greenhouse. By. F. William Rane.

No. 5. Bibliography of Birds in their Economic Relations to Agriculture. By Clarence M. Weed.

The Experiment Station has also undertaken for the present the publication of a series of pamphlets on Nature Study for the use of the teachers in our public schools. So far three of these, by Prof. Clarence M. Weed, have been issued and bear the following titles:

No. 1. The Pollination of Flowers.

No. 2. The Mission of the Birds.

No. 3. Plant Travelers.

Six press bulletins containing abstracts of regular bulletins and notes on their contents were also issued to the newspapers, in order to insure that the information reached as many people as possible. These press bulletins have resulted in requests for large numbers of copies of the regular editions.

The reports of the different departments are appended.

Respectfully submitted,

Fred W. Morse,
Vice-Director and Chemist.

THE ACIDITY OF CORN SILAGE.

FRED W. MORSE.

For several years, whenever there was an opportunity, the Department of Chemistry has pursued the study of the acids in silage. The total acids were determined at frequent intervals during several seasons, and the nature of the acids studied as much as was possible in the time.

To determine the total acids, a sample of silage fresh from the silo, weighing from 100 to 500 grams was macerated with sterilized water for several hours in the cold. The water was then filtered and the acid determined in an aliquot of the whole, by titration with standard alkali, and the percentage, for convenience, calculated as acetic acid.

The silage was cut in the customary lengths of three fourths of an inch.

The results obtained in different seasons and with different varieties are given in the following table.

Total Acids in Corn Silage.

Sanford corn, crop of 1895.

Six daily samples, December 17 to 24, 1895:

Average	1.05%	acetic acid.
Highest	1.23%	“
Lowest	.96%	“

Six samples, January 15 to February 5, 1896:

Average	1.12%	acetic acid.
Highest	1.32%	“
Lowest	.80%	“
One sample April 3, 1896	1.33%	“

Four samples, December 7--18, 1896, 1 year old.

Average	1.54%	acetic acid.

Leaming corn, crop of 1895.

Seven samples, February 20, to March 12, 1896.

Average	.67%	acetic acid.
Highest	.84%	“
Lowest	.50%	“

Mosby's Prolific corn, crop of 1895.

Five samples, March 17 to 31, 1896.

Average	.82%	acetic acid.
Highest	.93%	“
Lowest	.76%	“

Sanford corn, crop of 1896.

Three samples, February 12 to 26, 1897.

Average	1.95%	acetic acid.

Leaming corn, crop of 1896.

Three samples, March 5 to 18, 1897.

Average	1.47%	acetic acid.

The results of these two years show a marked variation between the two years and between the varieties, more particularly Sanford and Leaming.

In the pursuance of these studies it was noted that no regularity in amounts of acid occurred, and as soon as an opportunity occurred another series was taken up using as much care as possible to have uniform conditions of procedure during the course of the analyses. The study was made on the crop of 1899, consisting of Leaming corn. Two sets of samples were taken each time, one from the surface of the silo between feeding periods and the other not less than six inches below the surface. The maceration with water was conducted under uniform conditions.

Invariably the surface acidity was lower than that below the surface, and average results were .83% acetic acid and 1.03% acetic acid respectively. The results of the series of twenty-two determinations, running from October 17 to February 21, showed that maximum acidity occurred during November, and was practically constant during December, January, and February, and lower than in November.

The actual results obtained during the season are given in the following table, the figures being for acetic acid and averaged from the samples obtained from the surface and below the surface.

	Per cent.		Per cent.		Per cent.
October 17, 1899	0.74	December 2, 1899	0.78	January 6, 1900	0.94
October 30, 1899	0.69	December 6, 1899	0.91	January 17, 1900	0.96
November 2, 1899	0.84	December 13, 1899	0.95	January 24, 1900	0.93
November 10, 1899	1.03	December 19, 1899	1.03	February 1, 1900	0.93
November 14, 1899	1.14	December 23, 1899	0.95	February 7, 1900	0.96
November 22, 1899	1.04	December 28, 1899	1.02	February 14, 1900	0.89
November 28, 1899	1.01	January 3, 1900	0.90	February 21, 1900	0.91

AYRSHIRE HERD TESTS.

FRED W. MORSE.

Since 1894 the department of chemistry has conducted tests of several herds in the state, for the Ayrshire Breeders' Association. The plan of the tests has changed somewhat from year to year. The first test lasted but one day, then, for several years, the time required was two days; from 1898 to 1900, seven days were included; and finally, in 1901–'02, the test was made to consist of two days at monthly intervals throughout the year. Until the adoption of the monthly test, all the sampling and weighing was done by a station representative; but during 1901–'02, only one month's test was so conducted. The other monthly samples were sent by the owners to the station, accompanied by the weights of milk for the two days.

In all these samples the fat was determined by the Babcock test. The total solids were in most instances, until

1901, calculated from the lactometer readings and fat percentages, by Babcock's formula. During 1901, and in other years when samples were more than twenty-four hours old, the gravimetric method was employed.

The tests appear in the following tables, and probably show the composition of Ayrshire milk with respect to fat and total solids as well as is possible. The animals must be regarded as fully representative of the breed, and the number of cows in each herd is sufficiently large to insure a fairly average period of lactation. The percentages of fat range from 3.48 to 4.40, and those of total solids from 11.71 to 13.27. The general average for all the tests given, 3.88 per cent. of fat and 12.55 per cent. of total solids.

In scanning the columns of total solids and daily yield, one cannot avoid the conclusion that some of the herds are developing the quantity of milk at the expense of quality.

In the tests for 1901–'02, it was found that in the case of twenty-one cows whose periods of lactation allowed a comparison of the first and second months, fifteen gave the higher fat test in the first month, and thirteen produced the higher yield of milk in the second month. The table shows this result very clearly.

SUMMARY OF AYRSHIRE MILK TESTS.

OWNER.	Date.	No. of days.	No. of cows.	Fat.	Solids not fat.	Total solids.	Daily milk yield in lbs.
G. H. Yeaton	Jan. 24, 1894	1	19	4.03	9.23	13.26	....
C. H. Hayes	Jan. 25-26, 1894	1	11	3.72	......	....	18.4
G. H. Yeaton	Oct. 29-31, 1894	2	10	3.57	9.01	12.58	27.8
W. R. Garvin.............	Oct. 31-Nov. 2, 1894.	2	10	3.58	8.84	12.42	26.1
G. H. Yeaton	June 13-14, 1895	2	10	4.01	8.83	12.84	32.0
G. H. Yeaton	June 22-24, 1896	2	16	4.06	8.62	12.68	30.7
G. H. Yeaton	Dec. 21-23, 1896	2	14	4.08	9.19	13.27	26.2
G. H. Yeaton	June 23-25, 1897	2	14	4.01	8.85	12.86	29.05
C. H. Hayes................	June 28-30, 1897	2	12	3.70	8.54	12.24	26.52
W. R. Garvin.............	July 1-3, 1897	2	15	3.72	8.93	12.65	27.47
G. H. Yeaton	Jan. 12-14, 1898	2	10	3.98	9.28	13.26	29.3
W. R. Garvin..	Jan. 17-19, 1898	2	9	3.48	8.79	12.27	22.88
C. H. Hayes................	Jan. 17-19, 1898	2	16	3.89	8.77	12.66	18.5
G. H. Yeaton	Apr. 14-20, 1898	7	10	3.88	8.97	12.85	37.3
C. H. Hayes................	May 24-30, 1898	7	16	3.88	9.04	12.92	26.3
G. H. Yeaton	May 15-21, 1899	7	8	4.10	8.05	12.15	40.6
C. H. Hayes................	May 2-8, 1899	7	20	3.65	8.16	11.81	33.8
G. H. Yeaton	May 19-20, 1900	7	10	3.87	8.30	12.17	46.2
C. H. Hayes................	June 18-25, 1900	7	16	3.62	8.51	12.13	31.4

HERD OF E. J. FLETCHER, 1901-1902.

DATE.	Number of cows.	Fat.	Solids not fat.	Total solids.	Daily milk yield in lbs.
April, 1901	8	4.06	8.60	12.66	23.5
May, 1901	8	4.13	....	....	24.1
June, 1901	4	4.02	8.64	12.66	23.8
July, 1901	1	3.90	....	....	34.8
August, 1901	4	3.86	9.11	12.97	36.3
September, 1901	8	4.40	....	....	40.4
October, 1901	9	3.95	8.46	12.41	36.4
November, 1901	8	4.08	8.77	12.85	32.7
December, 1901	9	3.87	....	....	26.6
January, 1902	8	4.11	....	....	28.3
February, 1902	9	4.09	8.73	12.82	....
March, 1902	9	3.95	....	....	21.2

HERD OF G. H. YEATON, 1901-1902.

DATE.	Number of cows.	Fat.	Solids not fat.	Total solids.	Daily milk yield in lbs.
April, 1901	15	3.89	....	....	30.4
May, 1901	15	3.69	8.16	11.85	28.1
June, 1901	15	3.91	....	....	22.3
July, 1901	13	3.90	8.39	12.29	16.5
August, 1901	11	3.98	....	....	17.7
September, 1901	9	3.70	8.40	12.10	17.4
October, 1901	12	3.95	....	....	24.9
November, 1901	10	3.48	8.23	11.71	35.1
December, 1901	11	3.56	....	....	30.4
January, 1902	14	3.90	8.62	12.52	30.0
February, 1902	14	3.80	....	....	32.5
March, 1902	15	3.80	....	....	27.8

COMPARISON OF MILK YIELD AND PER CENT. OF FAT IN THE FIRST AND SECOND MONTHS OF LACTATION.

Cow.	MILK YIELD FOR TWO DAYS.		PER CENT. FAT.	
	1st mo.	2d mo.	1st mo.	2d mo.
Gladiola	69.3	71.6	3.10	3.15
Iona S.	71.0	74.5	4.25	4.00
Gebic	68.3	80.3	4.20	3.45
Oke Mar	72.2	82.5	4.30	3.60
Gada	80.8	77.1	3.50	3.10
Yucca	74.5	71.0	3.60	3.80
Lukolela	82.0	95.9	3.50	3.20
Olah	86.9	72.7	3.20	3.20
Xoa	76.8	93.5	3.40	3.40
Miss Olga	72.9	89.7	4.40	3.95
Biona	87.5	87.6	3.45	3.20
Freda	50.3	67.5	3.50	3.40
Hinda Douglas	80.0	81.0	3.75	4.00
Himona	80.0	85.5	5.50	3.85
Durwood	86.5	88.0	3.95	3.70
Collinwood	83.0	87.0	3.70	3.90
Cad's Victorien	55.5	66.0	4.15	3.20
Cad's Beauty	89.0	83.0	5.80	4.00
Banjo Music	91.0	73.0	4.80	3.40
Ramona	75.0	66.0	4.30	4.15
Belle Nixon	82.0	75.0	4.00	3.40

DEPARTMENT OF AGRICULTURE.

Professor Gibbs, during his connection with the department, continued the coöperative experiments with the U. S. Department of Agriculture, which were begun last year. One of these lines, viz., experiments with worn-out grass lands has been terminated this year by the lack of funds at the disposal of the Division of Agrostology to continue the work.

The experiments with clover seed will be continued next year at the request of the Division of Botany, In addition to these experiments, there were begun three series of plat experiments, viz.:

(1) A series of twenty-two plats, with eleven different systems of rotation of crops, to be continued four years.

(2) A series of eight plats, to determine the effect of varying the distance between plants in corn sown for the silo.

(3) Thirty plats devoted to variety tests of corn, both for ears and for silage. This series was practically a failure, because of the weather conditions throughout the season.

All the plats were carefully harvested, and all data and notes filed for Professor Gibbs's successor.

A series of dynamometer tests with harrows was conducted during the preparation of the fields in the spring, the data of which are on file.

DEPARTMENT OF HORTICULTURE.

The work in this department, while similar in many ways to that of previous years, has been greatly enlarged. Besides the work already alluded to in previous reports, which has been continued if not completed, new problems have been taken up. During the past season quite a beginning was made in studying the possibilities of the wholesale markets for horticultural produce from small growers. Besides growing a few crops that were thought advisable for testing for this purpose, an experiment was begun to determine the best methods of packing vegetables for the market.

As an educational feature, a large display of the produce from the station was exhibited at the Rochester fair, the New Hampshire Horticultural Society's Annual Exhibit, and the Durham Grange Fair. This display consisted of a large collection of both fruits and vegetables. A feature of the display was an exhibition of methods of packing for market. The work with muskmelons has been continued, but more in the line of fertilizer experiments, and tracing the origin of varieties. Besides the testing of new varieties of potatoes, some experiments on comparative tests of potato fertilizers, ready mixed versus home mixed, were begun. The use of legumes as an orchard cultivated crop was continued. Notes previously begun on fruits and other vegetables have been greatly added to and a large number of photographs for purposes of illustration have been taken. Three bulletins have been issued by the department during the year. The working up of notes from experiments for publication has been greatly hindered from the fact that the head of the department has had to carry extra work in the Department of Agriculture due to its frequent changes.

This being an apple season we had a large crop, of which 216 barrels have been sold and shipped, and the remainder are in storage. We grew about three acres of potatoes besides the numerous varieties in our trial grounds. The yield was very good; varieties used were Early Rose, Washington, and Green Mountain. They have averaged us about seventy-five cents a bushel for those sold, and we have still on hand about 400 bushels. We set out about one-fourth acre of celery, and have on hand in pits, ready for sale, about 2,500 bunches. Early in the season we sold about two thousand heads of early spring cabbages, a quarter acre each of beets, cucumbers, and lettuce, and during the season we also disposed of about one acre each of marrow squash, sweet corn, peas, and bell peppers. About an acre of muskmelons were planted, but the season was not a favorable one for them, although we secured some returns. The orchards were kept under cultivation, and bush beans were largely planted in them. We sold about 250 bushels of string beans during the season from these orchards, and the plants were then turned under for the benefit of the orchards. Currants and raspberries yielded a fair crop, but the strawberries were very poor. Plums did fairly well, many of the varieties not fruiting last year, bearing well this season. We put out about an acre and a half of tomatoes. The season was a poor one for this crop, and our extra work did not allow us to give it the attention in spraying and culture that is needed for best results. The crop paid well, however, and we got good returns for green fruit that was picked and housed until we were able to grade and pack it. The last shipment was sent to Boston during November.

It required about one thousand bushel-boxes for our shipment of vegetables during the season, besides the barrels used for cabbage, squash, etc.

The sales of the year have amounted to $876.26 as compared with $846.59 in 1901 and $662.50 in 1900. If to this amount is added the present value of produce already on hand at current prices, which should bring approximately $600, the sales would be $1,476.26.

In order to make a creditable exhibit at the fairs the men worked until nearly twelve o'clock at night for over a week, washing and grading vegetables, without extra compensation. Never has more real interest been taken in the work than was shown by those who assisted us this season.

An addition of thirty feet was made to the horticultural barn this fall in order to have room for a packing shed for fruits and vegetables. This is a great addition and one much needed, as there has been no space available for this work heretofore.

Throughout the year very efficient aid has been rendered by Mr. Harry F. Hall, assistant horticulturist.

F. Wm. Rane,
Horticulturist.

14th ANN RPT
1902

THE ORIGIN OF VARIOUS VARIETIES OF AMERICAN MUSKMELONS.

BY F. WM. RANE.

The work of studying out the origin and history of all our standard, well known, cultivated American muskmelons has been given considerable attention. The following is published as a record of what is accumulated at present:

While the varieties of American muskmelons have received attention by the New Hampshire Station * and an attempt at classification made,† it was thought that by a close investigation into the origin of each variety perhaps sufficient data might be obtained to indicate more or less the phyla or line of development.

The writer sent letters to all of our leading seedsmen throughout the country, asking them for all possible information in regard to their various introductions of muskmelons, viz.: date of introduction, description and photograph of the original fruit, where originated, by whom, whether a known cross, and if so its parentage, etc. He also wrote to many large growers throughout the country for similar assistance in tracing the origin and history of this fruit. Some of our leading agricultural and horticultural papers assisted likewise by publishing a notice free of charge asking for similar information, and each of the Agricultural College and Experiment Station horticulturists was consulted and asked to coöperate in the work.

From these various sources a very liberal response was received. Many seed firms were frank to say that they had not introduced anything of their own originating, and even most of those offered to the public were not of any definite known crossing, but variations or strains which had been brought out through selection. Some were supposed to be crosses from the fact that other varieties, which the chance seedling or strain seemed to resemble, had been grown near by. Seedsmen, growers, and horticulturists united in not

*Bulletins Nos. 52 and 72. †Technical Bulletin No. 2.

only giving me the advantage of their own experience and data, but in giving addresses of many persons whom they believed might assist me.

It has been interesting in accumulating this data to get the ideas of growers as regards the development of this fruit. Some seem to think there is nothing grown to-day that begins to compare with the olden-time varieties, while others see vast improvements.

All authorities seem to agree that the muskmelon doubtless originated in the orient, and even to-day it forms a staple article among the peoples of Persia, Italy. and Egypt.

The muskmelon is very easily susceptible of mixing where varieties are adjacent, and through this means many strains and types have been brought out. The evolution of the cultivated American muskmelon is interesting. One writer claims that Columbus brought the first seed to this country. There are very few instances on record of direct introduction of varieties in earlier times. In recent years the United States Department of Agriculture has introduced many, which may have a marked influence in the future. The famous Cassaba or Persian variety is said to have been introduced directly from Smyrna to the light soils of lower New Jersey, where it has flourished and become noted for its sweetness and fine flavor. It is believed that most of our thin-skinned, finely netted, and highly flavored varieties are of Persian origin. The rougher or hard-skinned varieties, like those so commonly grown in France, Italy, and other European countries, and known in this country as cantaloupes or rock melons, may have had a similar origin but have been developed differently.

The muskmelon most commonly known to America is, we believe, of the Persian type. While some cantaloupes are grown, and there are now and then varieties showing the cantaloupe characteristics, they nevertheless do not meet with as great success.

There has been more attention given to breeding the muskmelon during the past ten years than ever before. While many of the earlier varieties are still standard, new ones are rapidly taking their places. As with other European fruits, conditions have so changed under the new environment in this country that our present cultivated muskmelons are what may be termed strictly an American product.

After much correspondence the data at hand seems very inadequate. It was thought that a large number of our varieties would be found to be of definite origin, but they are not. Very few varieties are of known parentage; but instead are largely chance seedlings or strains of well known kinds.

Much general information was obtained through the two large wholesale seed firms of Chauncey P. Coy & Son, proprietors of the Elkhorn Valley Seed Gardens, and Frank T. Emerson, general manager of the Western Seed and Irrigation Company, both of which are at Waterloo, Nebraska. These firms are large growers of muskmelon seeds, and supply them for our principal seed houses. When any of the seed firms have obtained or originated a new variety, they turn the same over to these firms for future supplies.

The writer is unable to tabulate the data as completely as desirable, but offers the following quotations and table toward that end:

"We have sold three varieties of muskmelons to the houses that first catalogued them. The Banquet muskmelon was found by us in the hands of a gardener, who could give us no information about it save that he had grown it for a good many years, and had first secured his seed from some other farmer or gardener. We could not trace the matter back, and cannot say where or when the variety first appeared. The Green-fleshed Osage came from a variety called the Grand View (which was nothing more or less than an impure strain of Emerald Gem). While inspecting a crop of the Grand View we found a single vine bearing six well developed melons of an entirely different type; we picked the melons and next season planted the seed, and neither the first season nor at any time since have we found so much as one single impurity in this variety. It came absolutely pure and true from the start, and it is worthy of note that this green-meated variety came from a yellow-meated sort. We had only to continue planting until we had sufficient seed to sell, and then we sold it to Johnson & Stokes, who named it Green-fleshed Osage, because of its similarity in size and shape to the red-meated Osage. The perfected Delmonico was sold by us to Peter Henderson & Co., after some five or six years of selection continued from a ‘sport’ or impurity found in a field of their Delmonico. This sort kept reverting to the parent type, and was very hard to get pure and true to the new form. We have, at one time and another, saved and continued cultivation for several years, on distinct types of melons (usually sports found in fields of other sorts) to the number of twenty or thirty, only to find at last that the type we were working for could not be perpetuated. We have been working for eight years on a type of muskmelon in which each melon contains both yellow and green meat intermingled, but we have not yet succeeded in getting the variety sufficiently established to sell for introduction. This was produced from a patch in which alternate hills were planted to different varieties, and curiously enough is the result of crossing in this manner two *yellow*-meated varieties. We also note that the impurities that we throw out of our yearly trials of this cross are green-meated, and we have not yet found any melons in the cross with wholly yellow meat. We cannot offer any explanation of this fact, nor of what we have said about the Green-fleshed Osage."

CHAUNCEY P. COY & SON,
Nebraska.

LONG ISLAND BEAUTY MUSKMELON.

INTRODUCED 1893.

"‘A variety of the Hackensack type, originated on Long Island. It is of very superior quality, with green flesh, and densely netted. In shape it resembles the Hackensack, but is slightly more ribbed, and is decidedly the most attractive looking melon we have ever seen. Besides being the most beautiful it is also the earliest of all. Out of a collection including every standard variety, it produced the first ripe melon of the season. This gives it especial value for market-gardeners."

J. M. THORBURN & CO.,
New York.

MILLER CREAM MELON.

"This melon was originated by John D. Miller of Elmyra, N. Y., in the year 1878, it being doubtless the result of cross between Sill Hybrid and Cassaba. It has a very thick flesh, the seed cavity being very small, is of a salmon color, and melting in quality. The rind is thin and of a green color. The vine itself is a strong grower and is very productive, the ground being covered with fruit. This was first catalogued by us in the year 1885."

JAS. J. H. GREGORY & SON,
Massachusetts.

"The Osage we believe to bė an improved selection from Miller's Cream, which was introduced by J. J. H. Gregory of Marblehead, Mass., who can tell you more about its origin.

"The Osage Gem is a cross between the Osage and Netted Gem, and was very carefully made by one of our Michigan growers. The Paul Rose was bred by Mr. Rose, being a carefully selected type of small, solid, round, thick-meated Osage, and has a little more netting than the type of Osage which we use."

VAUGHAN'S SEED STORE,
Illinois.

"I have never given any attention to muskmelons except in attempting to cross melons by cucumbers, or more particularly to influence the flavor by the application of cucumber pollen. In this I was never successful."

FRED W. CARD,
Rhode Island.

"We are the introducers of the Vine Peach and Garden Lemon. We do not think, however, that they would really belong to the muskmelon family, as they are not usually eaten in the natural condition, but are preserved or pickled. We have never been able to get them perfectly pure. There are always some fruits which are large in size and appear to be midway between cucumber and muskmelon, and we are inclined to think that this vegetable is from a hybrid, or cross between the muskmelon and cucumber, but we do not know where they originated. The Vine Peach we found mentioned in the *Chicago Inter-Ocean* about fifteen years ago, and we wrote to the lady who mentioned this new vegetable and obtained all of her stock of seed. They have since then been renamed Vegetable Orange or Mango Melon by some of the eastern seedsmen. The Garden Lemon was sent us by one of our southern customers who had no name for it but simply thought that we would be interested in it. It is not really as desirable as the Vine Peach."

IOWA SEED CO,
Iowa.

"I introduced the winter melon named Eden, and also have brought into prominence the famous Russian winter muskmelon named Khiva (Agri. Dept. No. 114), and the N. E. Hansen muskmelon (Dept. No. 116). My business is strictly with winter melons, and I am the only one who has made a commercial success in that line. Have done quite a business with the United States Department of Agriculture in testing, and have sold them hundreds of dollars' worth of seeds."

J. F. BROWN,
Utah.

"We get all our cantaloupe seed from Rocky Ford, Colorado."

A. SARBOUGH,
California.

"We have introduced only one muskmelon, our Ideal. It was originated by Professor Price of the Texas Agricultural and Mechanical College, College Station, Texas, and he sold us the entire interest in it. It is interesting that we had already named it the Ideal, when we received a letter from Professor Price suggesting the same name. It is very productive, very sweet, and of better flavor than any melon with which we are acquainted. The flesh is a rich yellow, but occasionally we still find one with green flesh, as one of its parents was green-fleshed."

GEO. TAIT & SONS,
Virginia.

"Regarding the New Orleans Market muskmelon would say that it has been the only muskmelon that gave satisfaction in the immediate vicinity of New Orleans. Northern varieties do not succeed so well, they have no taste the first year and must be acclimated to be of any market value. Even the New Orleans Market muskmelon does not produce the same sweet melon if the seed was grown North. Our truckers are therefore very anxious to procure this seed genuine and of southern production.

The melon grows to a large size, larger than the large Hackensack, is deeply scalloped and very roughly netted. Flesh pale green to yellow, very deep, juicy, exceedingly sweet, and of a delicious flavor."

E. W. EICHLING,
Louisiana.

"The variety of melon called 'Large California Nutmeg' is a variety that was grown for many years by a melon grower on the Sacramento River and was formerly known as the 'Runyon Melon.' We never heard its history or origin. It is the best large shipping Canteloupe that we know of and we cannot find anything in the East to correspond with it. It is a very large, oblong melon, solid, of a nutmeg character and of a very fine flavor. It is considered the best late shipping melon in California and commands the highest price.

"We have taken hold of this melon for the last two years, as it was partially run out, and have selected the seed so as to bring up the quality."

Cox Seed Co.,
California.

Variety.	Origin.	Introducer.	Year.
Extra Early Hackensack	Selected Hackensack	Henderson	
Large Larly Hackensack		Henderson	
Early Prolific Nutmeg		Burpee	
Netted Gem		Burpee	1881
Rocky Ford	Selected Netted Gem	Rocky Ford Growers	
Osage	Selection of Miller's Cream	Vaughan	
Emerald Gem		Burpee	1886
Green Citron		Landreth	
Norfolk Button		Johnson & Stokes	
Surprise	White Japan X Orange Christiana	Price & Knickerbocker	1876
Bay View	Cassaba X Large California	Burpee	1877
Grand Rapids	Chance seedling	Brown Seed Co	
Chicago Market	Selection the Montreal	Vaughan	
Montreal Market		Burpee	
New Orleans Market		C. W. Eichling	
Baltimore Market	Chance seedling	J. Bolgiano & Son	1872
Anne Arundel	Selection Baltimore Nutmeg	J. Bolgiano & Son	
Champion Market		Burpee	1887
Perfection	Chance seedling	Maule	
Princess		J. & S	
Miller's Cream	Sill's Hybrid X Cassaba	Gregory	1885
Missouri	Accidental sports	Landreth	1892
Irondequoit		Vicks	
Cosmopolitan	ChanceCross of American and European.	Ferry	1894
Banquet	Chance seedling	Henderson	
Tip Top		Livingston	
Melrose		Burpee	
Green-fleshed Osage	Selection of Grand View	J. &. S	
McCotter's Pride	Sport of Peerless	Ferry	1897
Paul Rose		Vaughan	
Extra Early Roof	Accidental sport	Landreth	1878
Long Island Beauty.	Selected Hackensack	Thorburn	1893
Banana		F. Hurd	
Shumway's Giant		Shumway	
Osage Gem	Cross Osage X Netted Gem	Vaughan	
Golden Eagle		Burpee	
Defender	Sport of Paul Rose	Ferry	
Matchless		Burpee	
Newport	Selected Jenny Lind.	Henderson	
Jersey Belle	Selected Jenny Lind.	J. &. S	
Shippers' Delight		“	
Norfolk Button	Chance seedling	“	
Sweet Home		“	
Delmonico		Henderson	
Paul Rose	Selection of Osage	Vaughan	
Grand View	Selection of Emerald Gem		
Perfected Delmonico	Sport of Delmonico	Henderson	
Carmes	Imported from Syria.	Henderson	
Oklahoma	Chance cross Rocky Ford and Hackensack	J. W. Tetrick & Son	
Khiva Winter	Foreign	F. Barteldes & Co	
Large California Nutmeg	Runyon Melon	Cox Seed Co	
Runyon Melon	Chance seedling	Cox Seed Co	
Ideal	Known cross (?)	Geo. Tait & Sons	
New Early Hackensack	Selected Hackensack	Burpee	1887

DEPARTMENT OF ENTOMOLOGY.

The work in this department has followed closely the lines heretofore laid down for our investigations of the injurious insects and other animals of the state. Three lines of work have been completed and bulletins issued upon them, while several new lines have been begun.

Eight bulletins have been issued by this department during the year, the titles of which are given in the list of publications.

Many investigations of life histories and experiments with remedies have been made in the case of the following insects:

The San Jose or Pernicious Scale.
The Cabbage Worm.
The Striped Cucumber-beetle.
The White Fly of Greenhouses.
New Hampshire Mosquitoes.
The Potato Flea-beetle.
Oyster-shell Bark-louse.
The Cankerworm.

The results in several of these cases are nearly ready for publication, while in the others further time is needed for their completion.

The most notable development in our work during the year has been the discovery of the Pernicious or San Jose Scale in our state. This is one of the most dreaded orchard pests, and it will be fully discussed in a bulletin at an early day.

In all the work of the department I have had the efficient assistance of Mr. Albert F. Conradi, while during the summer months assistance in economic work was rendered by Mr. A. R. Merrill.

Clarence M. Weed,
Entomologist.

DEPARTMENT OF BACTERIOLOGY.

During the past year this department has been engaged in the work of studying the fungous diseases of plants and their treatment. The especial diseases under consideration have been the peach leaf-curl; the diseases of the apple—scab, sooty spot, brown spot, leaf spot, and canker, also the various rots affecting the mature fruit; downy mildew of cucumbers and melons.

The most notable fact in regard to fungous diseases during the past season was the serious outbreak of apple-scab. During the past ten years, the scab, while affecting certain susceptible varieties more or less, has not caused very serious damage. Since about 1895, in the vicinity of Durham it has been rather difficult to find Baldwin, Greening or Northern Spy apples sufficiently affected with the scab to serve as good illustrations of the disease; but during the summer of 1902, the scab became unusually abundant and did a large amount of damage, attacking many varieties which usually suffer little, among them the standard varieties mentioned above. The outbreak seems to have been widespread. As to the cause, the prevailing weather conditions would appear to be the most probable one. The most striking feature of the weather was the unusually low temperature which prevailed, while the rainfall was abundant but hardly to be considered excessive.

It is difficult to estimate the amount of loss caused by this outbreak but it would seem safe to set it at from one fourth to one half of the crop. Our experiments on the Baldwin demonstrated the efficiency of the Bordeaux mixture in the prevention of the disease. The scab attacks the foliage of the apple as well as the fruit, but a proportionate increase on the leaves last season was not observable.

Another disease of the apple, which was more abundant than usual, was the leaf-spot, a fungus distinct from the scab and characterized by the presence of numerous small circular brown spots on the leaves. This disease was generally prevalent and from several localities was reported as causing a serious dropping of the foliage. The brown spot on the Baldwin appeared to be less abundant than on some previous bearing years.

Peach leaf-curl did not develop to a serious extent. Brown rot of the peach and plum, while serious, did not appear unusually so.

Downy mildew of the cucumber and muskmelon, which appeared about the first of August, 1901, and did so much damage, did not attack the vines this year till about two weeks later, when it rapidly destroyed them. In our experiments in treating this disease Bordeaux mixture proved very effective, the sprayed vines remaining in good condition till killed by the frost.

Of the potato diseases the late blight or rot did much damage throughout the state. In the station field spraying with Bordeaux mixture largely prevented the disease as usual.

H. H. Lamson,
Bacteriologist.

METEOROLOGICAL REPORT.

Observations for the year, July 1, 1901, to July 1, 1902, have been continued as usual, and have been under the immediate charge of R. L. Lunt, New Hampshire College, class of 1904, as observer. Signal flags, indicative of the weather for the succeeding night and day, have been displayed throughout the year. The observations taken have been the same as in previous years, viz.: 8 A. M. and 8 P. M. readings of barometer with attached thermometer; of standard, maximum and minimum thermometers, and of wet bulb thermometer throughout the growing season. The average wind direction for the day, the amount of cloudiness, the precipitation in inches of water and the snowfall, including the depth of snow on the ground each day of the winter, were also noted.

March was the most remarkable month of the year. The temperature was 8 degrees and the precipitation 2 inches above the average for seven years past. The total rainfall for the month was 7.28 inches which was the greatest for the year except December.

On the other hand November and June were relatively cold months, with an average of 5 degrees each below the mean. November also had the greatest deficiency in rainfall, viz.: 3 inches. August and May were the driest months, but there was no marked lack of rain during the whole year.

As usual, July was the hottest month and it contained an unusual hot spell lasting for ten days from July 14 to July 24. The first frost did not occur till October 18, September and October both having quite uniform temperatures. The winter as a whole also lacked extremes of temperature and there was very little sleighing through the season. For the first time for a series of years a considerable body of snow fell in December, but it did not remain for any length of time.

C. H. PETTEE,
Meteorologist.

PUBLICATIONS OF EXPERIMENT STATION.

The following publications of the Station are available for distribution:

No. 2. Feeding Experiments.
No. 3. When to cut Corn for Ensilage.
No. 4. The Science and Practice of Stock-Feeding.
No. 5. Fertilizers and Fertilizing Materials.
No. 6. Experiments with Fertilizers.
No. 7. Test of Dairy Apparatus.
No. 8. Feeding Experiments. Part 1. Principles of Feeding. Part 2. Corn Meal, Middlings, Shorts, and Cotton-Seed Compared.
No. 9. Effect of Food upon Milk.
No. 11. Pig Feeding. Part 1. Results of Feeding Skim Milk and Corn Meal versus Corn Meal and Middlings. Part 2. Digestion Experiment.
No. 12. Fertilizer Experiments.
No. 14. Ensilage in Dairy Farming.
No. 16. Effect of Food on Composition of Butter Fat.
No. 17. Stock Feeders' Guide.
No. 18. Effect of Food on Milk.
No. 19. Spraying Apples and Pears against Fungi.
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